Fish and Other Field Sampling

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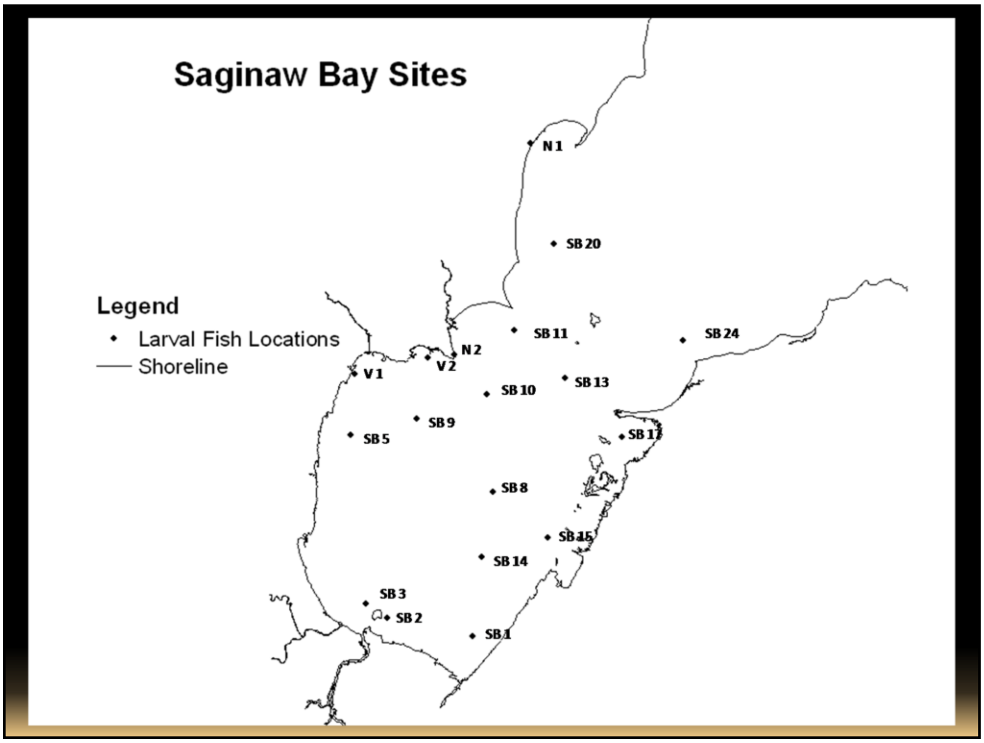
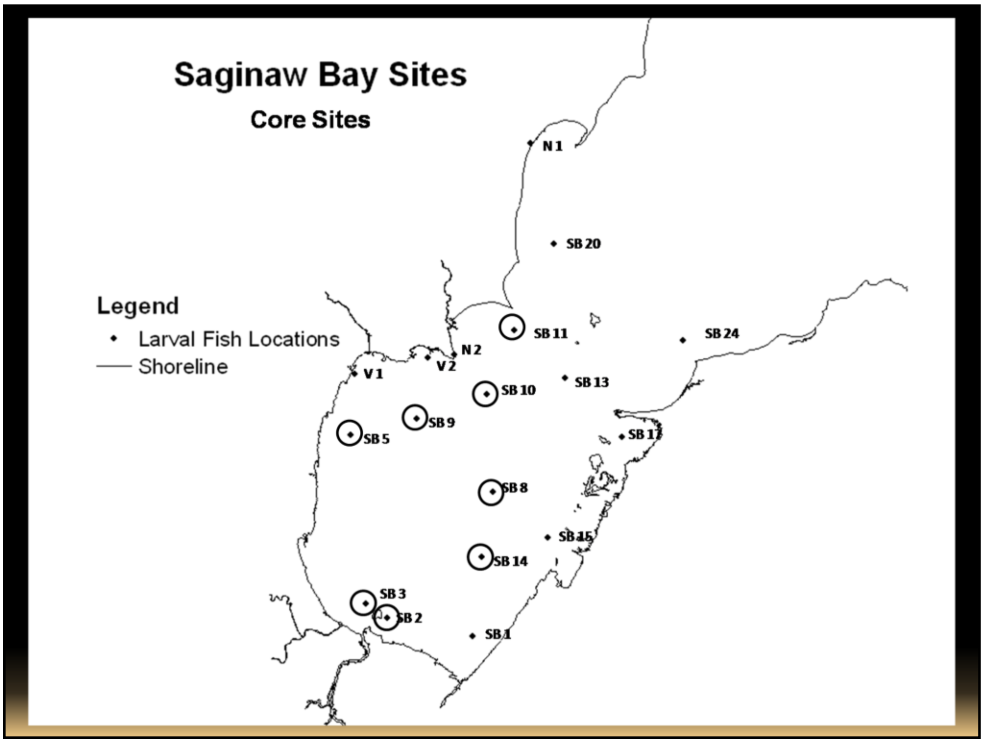
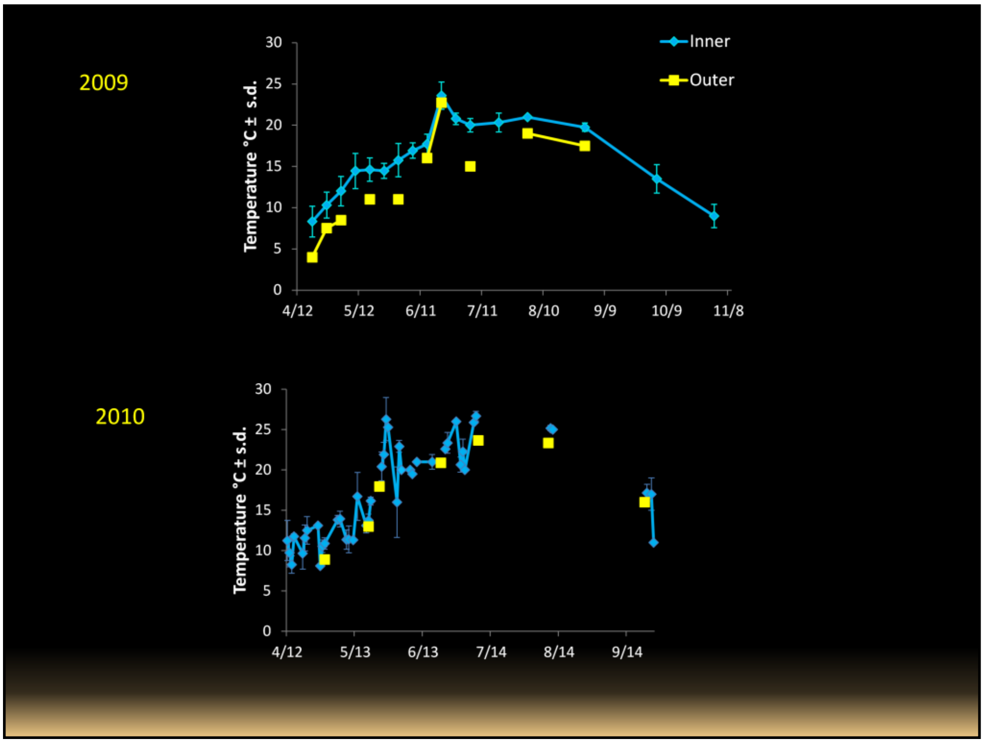
Title Slide



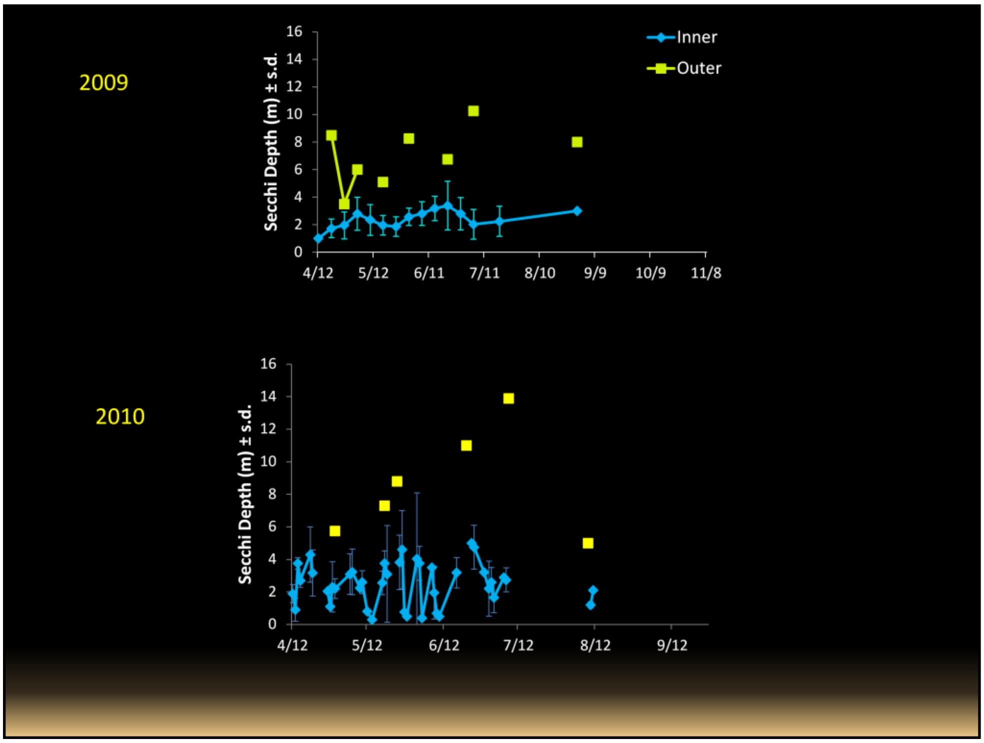
Sampling locations for the larval fish components of the Saginaw Bay study. Note the 4 nearshore sites on the northwest side of the bay; sampling at these nearshore sites included larval fish tows in the channelized portions of the Tawas River (Tawas), Au Gres River (Au Gres), and the Pine River (Wigwam Bay).



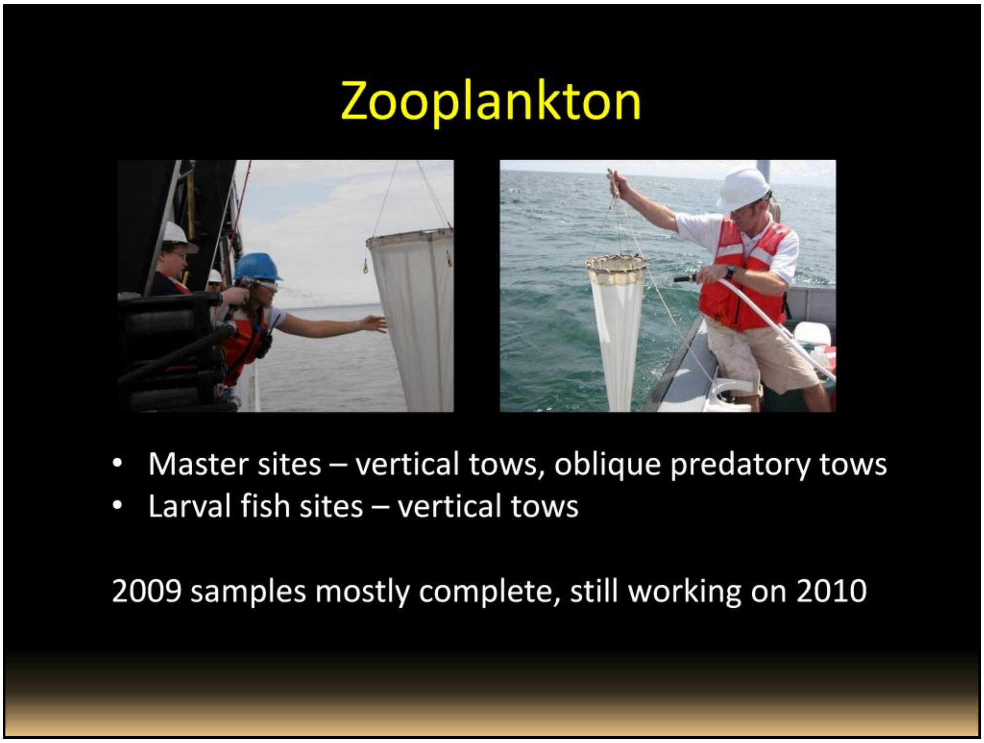
Core sites for larval fish sampling. These are the 8 sites we were able to sample nearly every week (other sites were harder to get to on a consistent basis due to weather and boat issues). Samples used for analyses are primarily from these 8 sites.



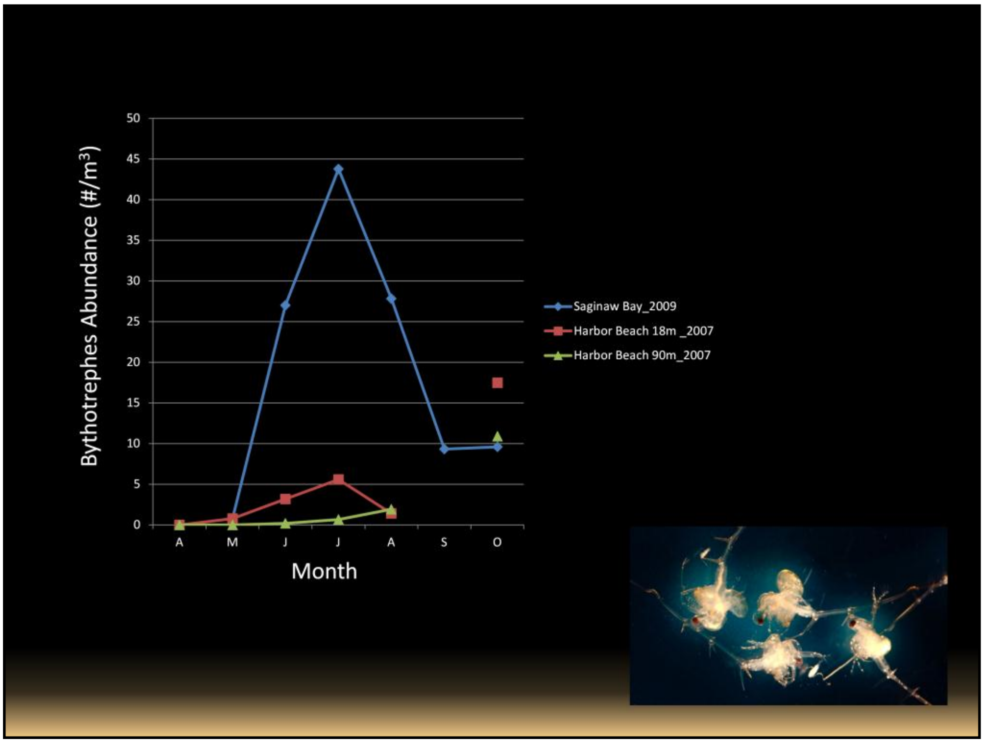
Temperature profiles from surface measurements taken during fish sampling (Top = 2009, Bottom = 2010). The apparent increased variability in 2010 is because 2009 was summarized by week, while 2010 was not. Temperatures were generally warmer in 2010.



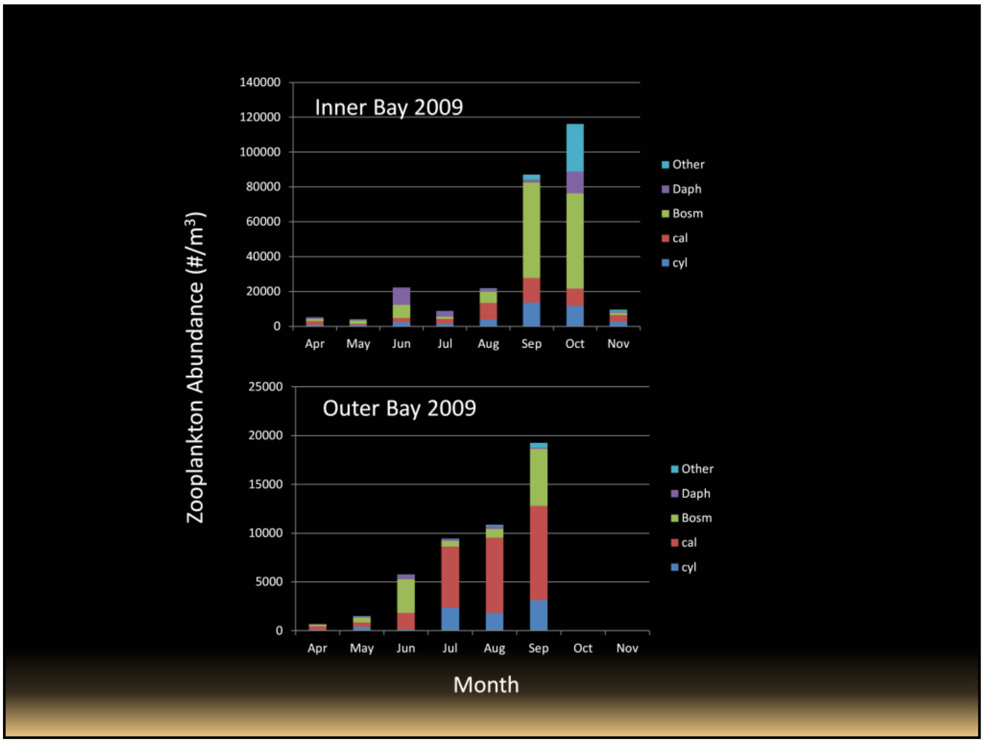
Secchi disk trends from measurements taken during fish sampling (Top = 2009, Bottom = 2010). The apparent increased variability in 2010 is because 2009 was summarized by week, while 2010 was not. Secchi measurements were generally somewhat deeper in 2010 (many times the disk was visible on the bottom).



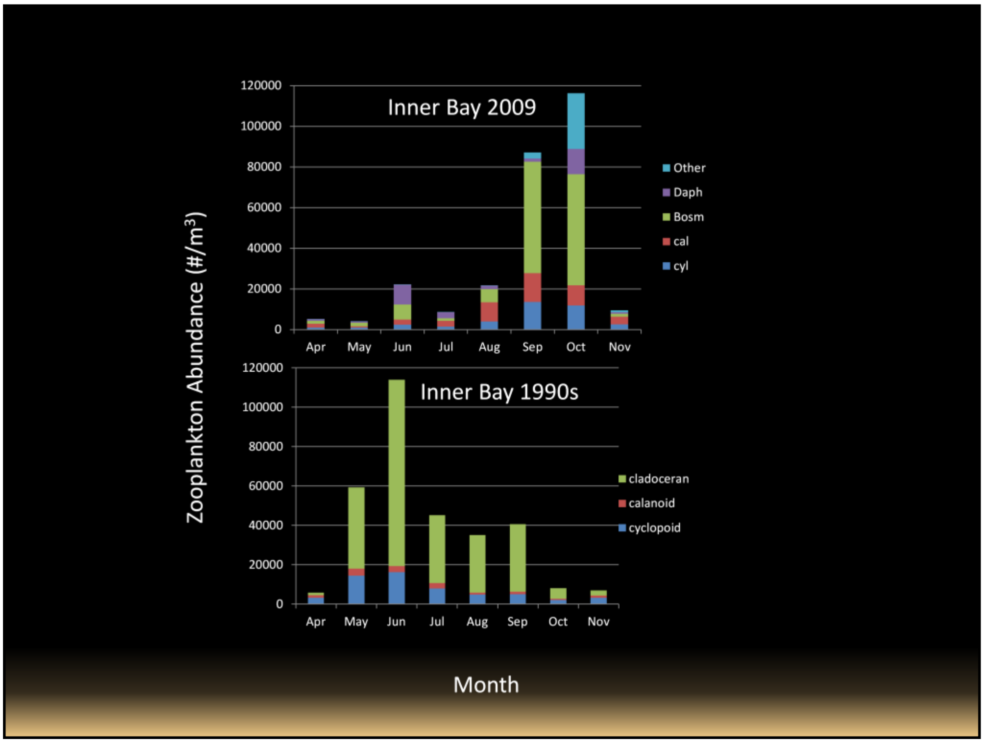
Overview of zooplankton sampling. Vertical tows with a 64µm net were done each time we sampled fish at each of the master and larval fish sites. Oblique tows with the 333µm side of the Bongo net (larval fish net) were used to quantify predatory zooplankton densities (*Leptidora* and *Bythotrephes*). We are still working on counting and IDing zooplankton from 2010 samples.



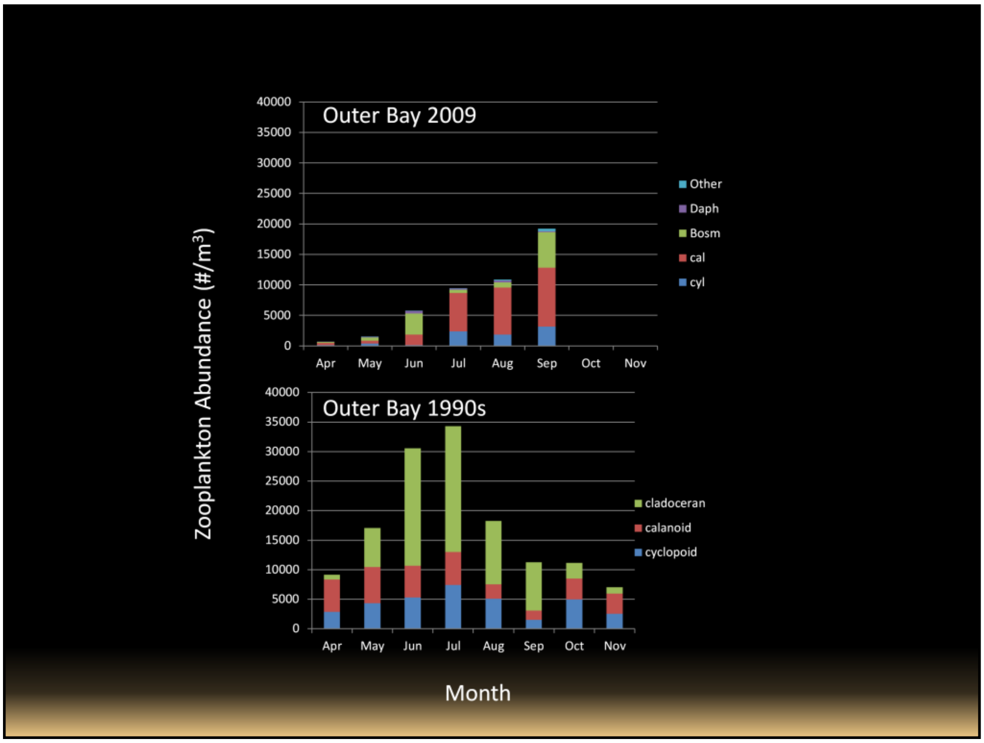
Bythotrephes densities estimated from this study (Saginaw Bay_2009) and from estimates for Lake Huron in 2007. Note that densities in Saginaw Bay are much higher than the main basin of Lake Huron, and the peak occurs earlier in the bay. Some researchers' estimates indicate that *Bythotrephes* are the dominant planktivores in the main basin of Lake Huron, so the estimate that densities are much higher in Saginaw Bay is especially important to note. One caveat is that *Bythotrephes* were sampled with different gear in the Lake Huron study, which might result in underestimating density, but this gives a sense of differences in Bay vs main lake.



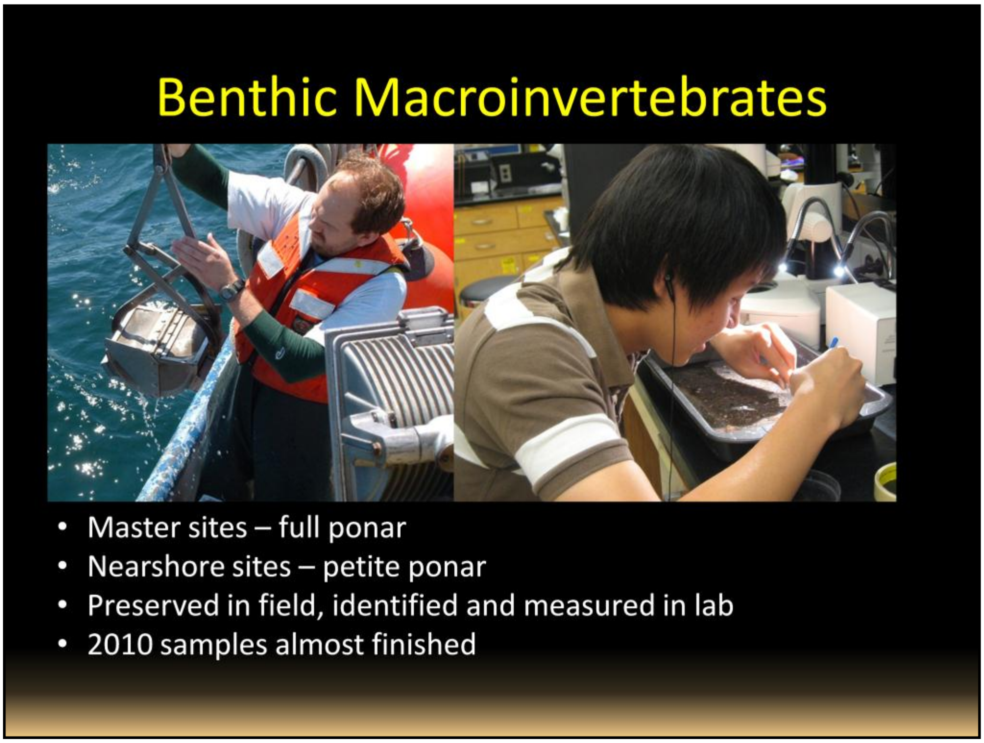
Trends in total zooplankton (separated by taxonomic group, i.e. cyl=cyclopoid copepod) for 2009. *Bosmina* is important in the inner bay, while calanoid copepods are important in the outer bay (similar to the low-productivity waters of Lake Huron proper).



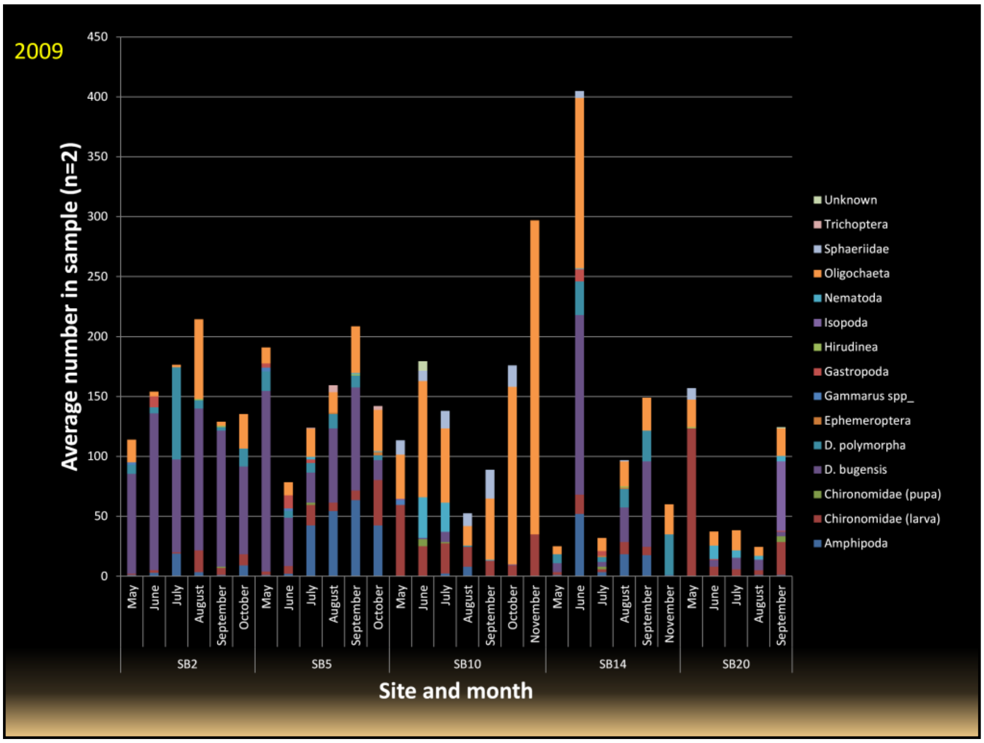
9. inner Saginaw Bay. Note reverse in peak timing—temperature, or due to prevalence of Bytho early in 2009/presence of alewife in 1990s? Also note more calanoid copepods in 2009.



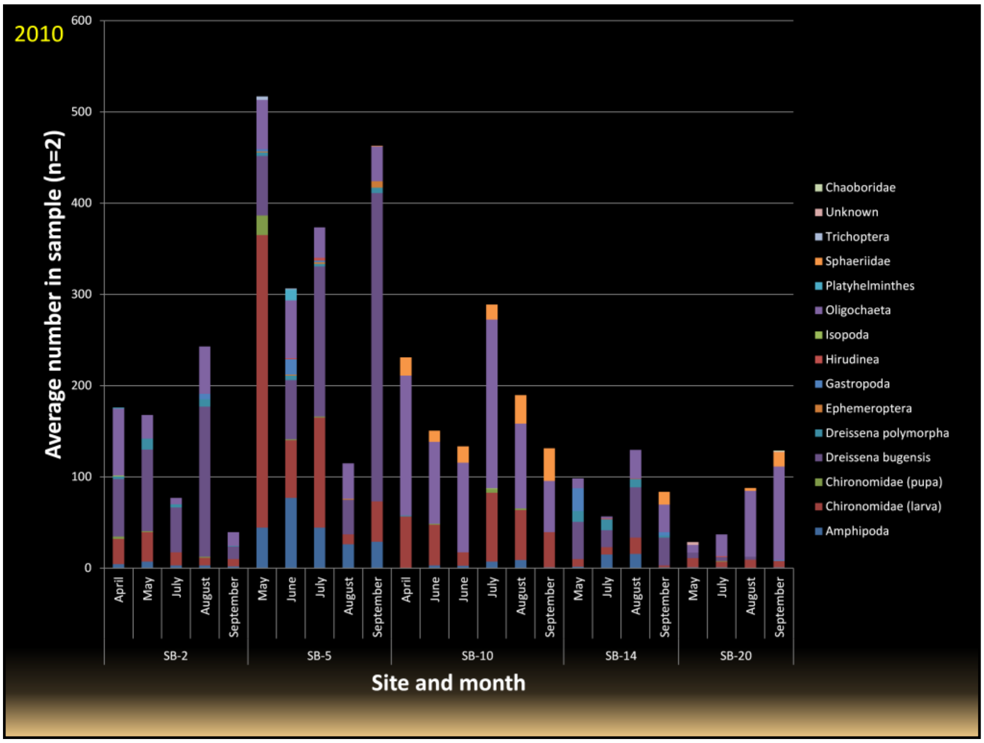
A similar change of trends has occurred in the outer bay. Some reduction of springtime densities might be expected in many areas of the great lakes due to the Dreissenid-induced reduction of the spring diatom bloom. However, the dynamics of Saginaw Bay (especially inner bay) zooplankton might be expected to be driven by the influence of the Saginaw River, instead.



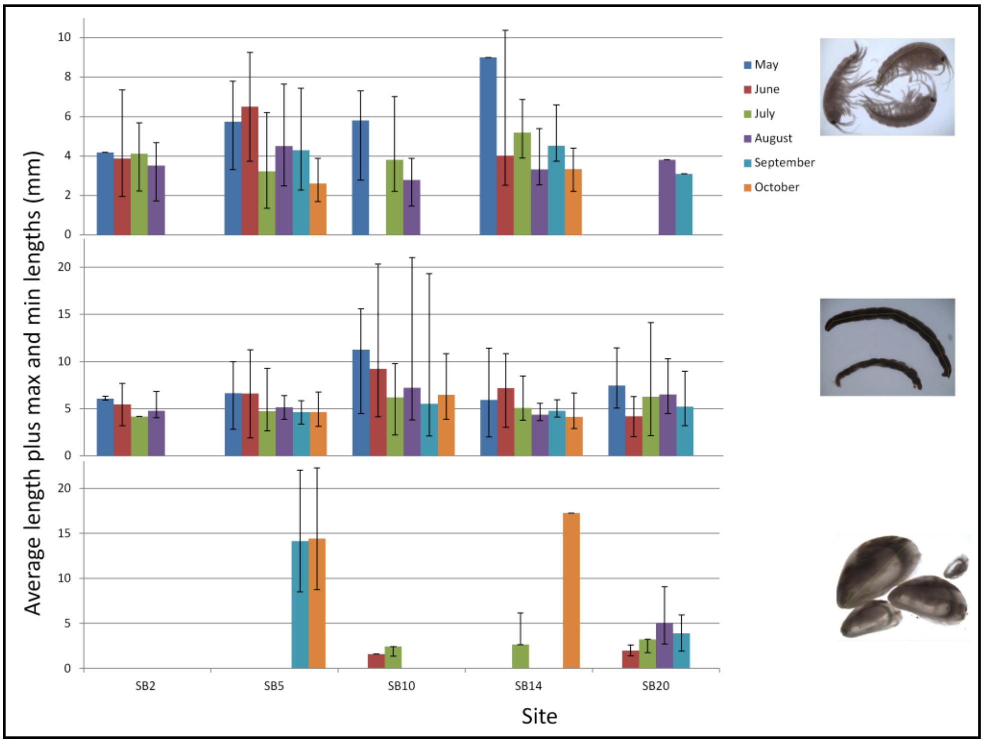
Benthic macroinvertebrates were sampled with ponars at five offshore master sites and four nearshore locations. At master sites, two full ponars were collected once/month. These dates coincide with trawl dates. At nearshore sites, one petite ponar was collected whenever we performed seines and/or larval fish sampling. All samples were preserved in 5-10% formalin in the field and sorted, identified and measured back in the lab. We have processed almost all samples from both 2009 and 2010 but still need to measure most lengths from 2010.



Breakdown of 2009 counts by where and when they were collected. These include offshore master sites only. Dreissenids make up a large proportion of the counts (no biomass estimates yet) at sites 2 and 5. Other sites are dominated by different taxa. SB20 is the only outer bay site.



This is again based on count data, but this time from 2010. The general patterns seem similar.



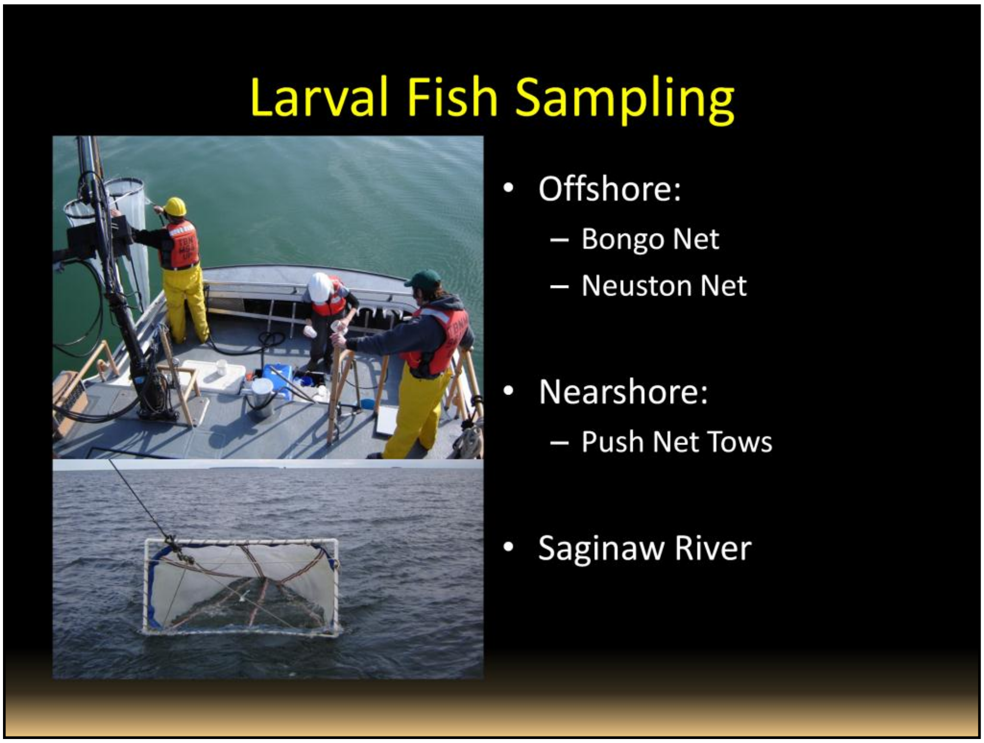
These are 2009 length data for the three most abundant groups (amphipods, chironomid larvae and dreissenids) by site and month collected. We measured up to 20 individuals per ponar (or up to 40 per site/date because there were two ponars). The error bars indicate maximum and minimum lengths measured. Lengths of amphipods and chironomids generally seem to decrease over the year while sizes of dreissenids remain the same.

We are looking at the macroinvertebrates in terms of availability as fish food. We are particularly interested in seasonal differences as Tom Nalepa has done extensive work on long-term trends. We also plan to do some community-level analyses to see if certain taxa always show up together, e.g. amphipods utilizing dreissenids as habitat. This would indicate that fish going for low energy density items like dreissenids may get a higher density item as a sort of by-catch.

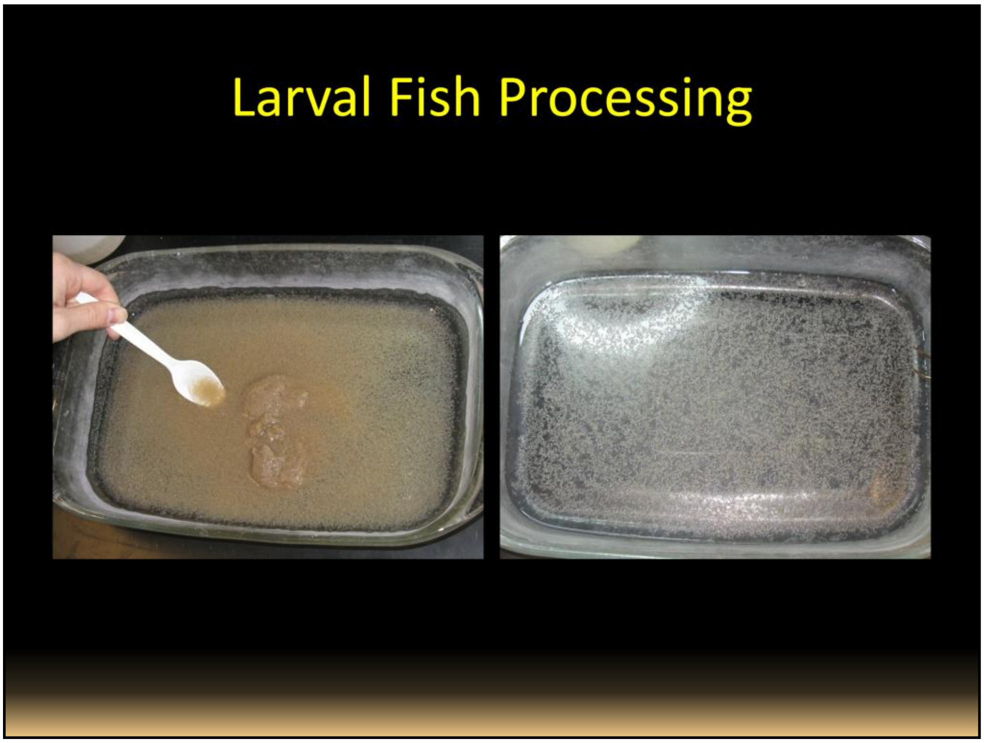
Burrowing Mayflies

- In western portion of inner bay?
  - Have found *Hexagenia* at SB5 (both years)
  - Also at some nearshore sites
  - Other burrowing mayflies (*Ephemera,* Polymitarcidae)
  - Adult *Hexagenia* in larval fish tows
  - In guts of fish

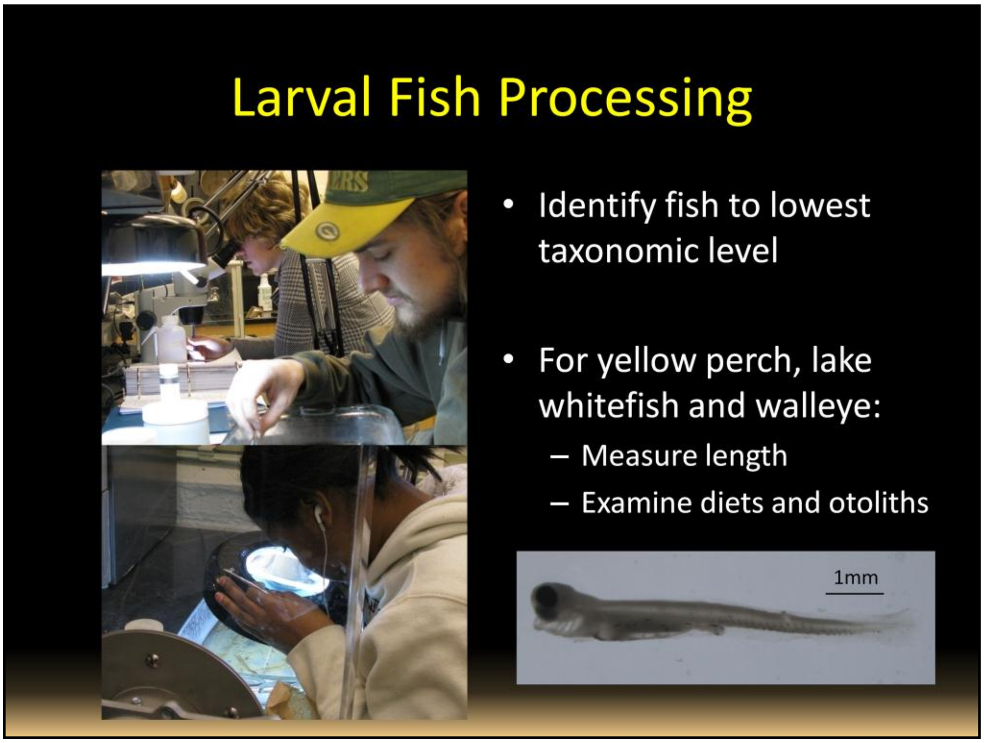
We have found Hexagenia in the bay at a few nearshore sites and one offshore site. If they’re there, I think they are likely in the western portion of the bay. We’ve found Hexagenia exuviae in larval fish tows in the western portion of the bay. We have also found burrowing mayfly parts in fish guts – these fish were usually collected in the western portion of the bay. Historical records have Hexagenia in the eastern portion of the bay so this may be a recolonization event (which is really cool).



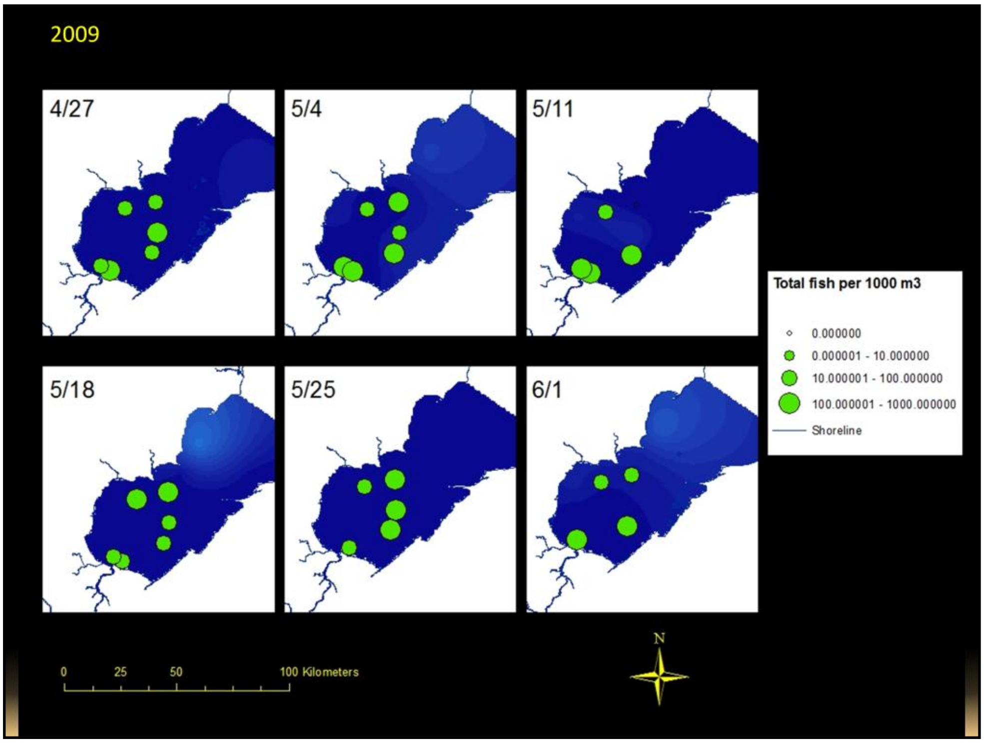
This is a summary of how we sampled larval fish. Offshore (with the NOAA boat) we used a bongo net (top picture) with mesh of 333µm on one side and 700µm for smaller larvae, and a neuston net (bottom picture) with mesh of 1000µm for larger larvae transitioning to juveniles. Nearshore a push net was used to sample larval fish (500µm) from a john boat. We also sampled in the extreme lower portions of the Saginaw River when we could with the bongo nets and NOAA boat, especially early in the season to attempt to catch larval walleye.



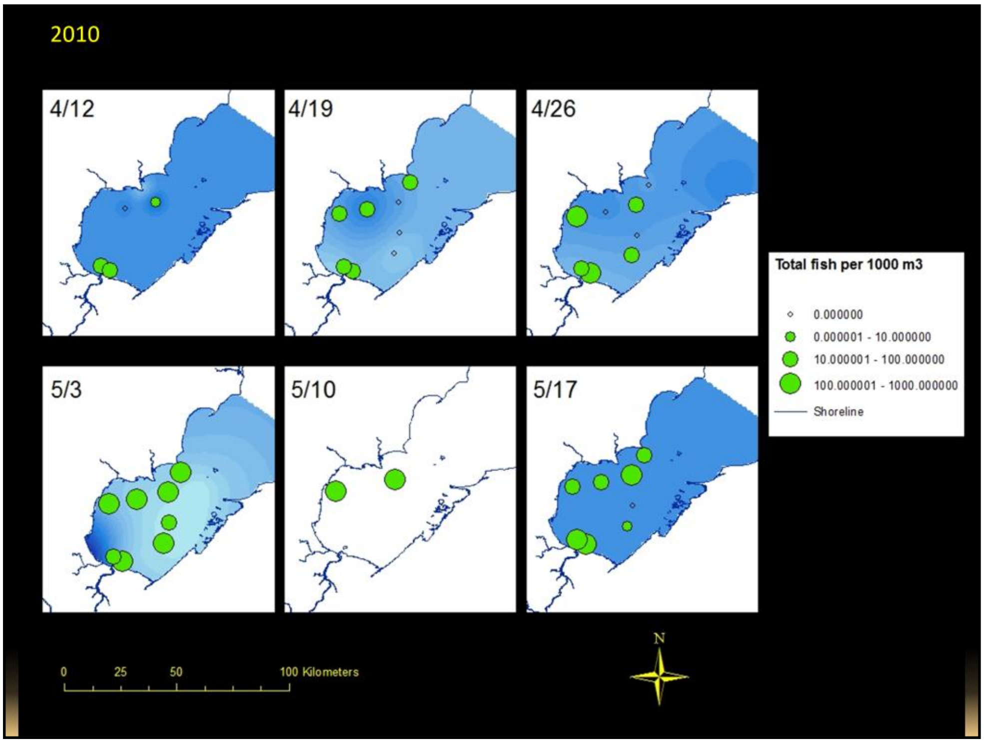
After collecting larval samples, we had to sort through them to find larval fish among zooplankton, phytoplankton, and other material. This was a very time-consuming process. The left picture shows a full sample, from which we would spoon out a portion at a time to pick in a pan (right picture); this was repeated until the sample was finished.



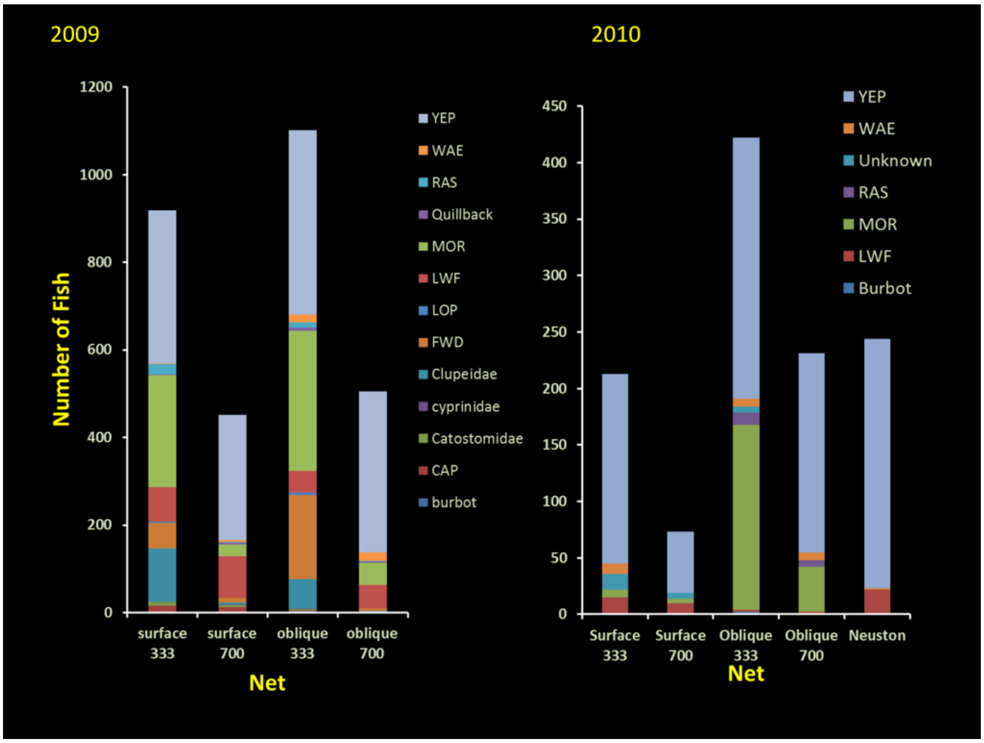
This slide describes the next steps after finding larval fish. Most fish we could identify to species, but smaller larvae (such as Moronidae) were hard to identify, so we were only able to ID to family. For the species we were most interested in (yellow perch, whitefish, walleye), we measured total length with a digital camera and software program, examined diet contents, and removed otoliths to determine age in days by counting daily growth increments.



This slide shows where we caught larval fish (using the 6 most-often sampled sites) during 6 weeks in the spring of 2009. Sizes of circles correspond to density estimates (larger equals more fish). The blue shading represents temperature (relative scale) interpolated from surface temperature measurements we took while sampling fish. Lighter blue is **cooler** in this case.



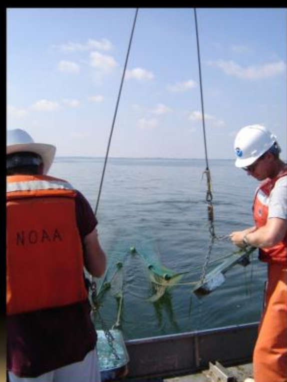
This slide shows where we caught larval fish (using the 8 most-often sampled sites) during 6 weeks in the spring of 2010. Sizes of circles correspond to density estimates (larger equals more fish). The blue shading represents temperature (relative scale) interpolated from surface temperature measurements we took while sampling fish. Lighter blue is **warmer** in this case. There were gale warnings for much of the week of 5/10, preventing sampling at all but 2 locations (2 points was not enough for. This was especially unfortunate because the peak of the yellow perch hatch likely occurred during that time.

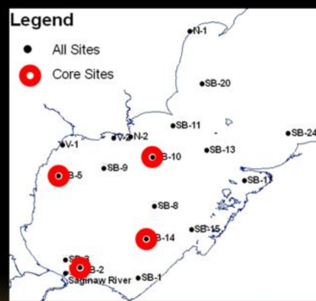


These are graphs representing what we caught in various gears during 2009 (left) and 2010 (right). The 333µm side of the bongo net often caught more larvae, since the smallest larvae could be extruded through the larger mesh of the 700µm side. We used the neuston net very infrequently in 2009, which is why those data are not included here. Many of the samples have not been picked for 2010, especially later in the year, which is why species diversity appears lower.

YOY, Juvenile and Adult Fish

- Bottom trawling
  - 2009: 1st week of month, May – Nov.
  - 2010: 2nd or 3rd week of month, April-Nov. (no Oct.)

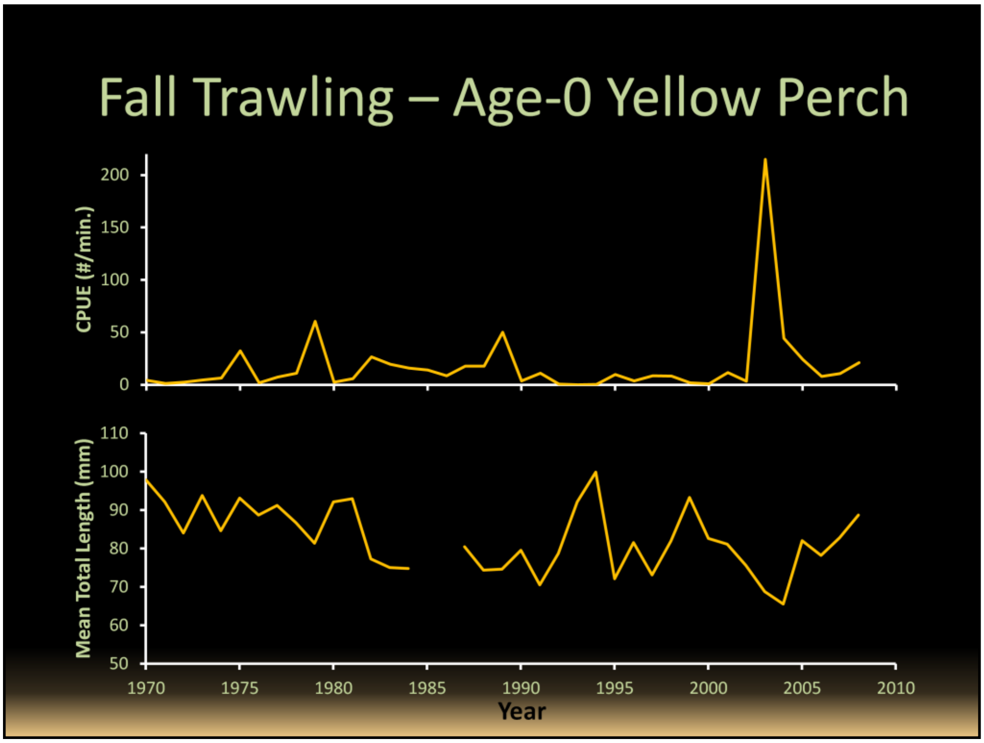




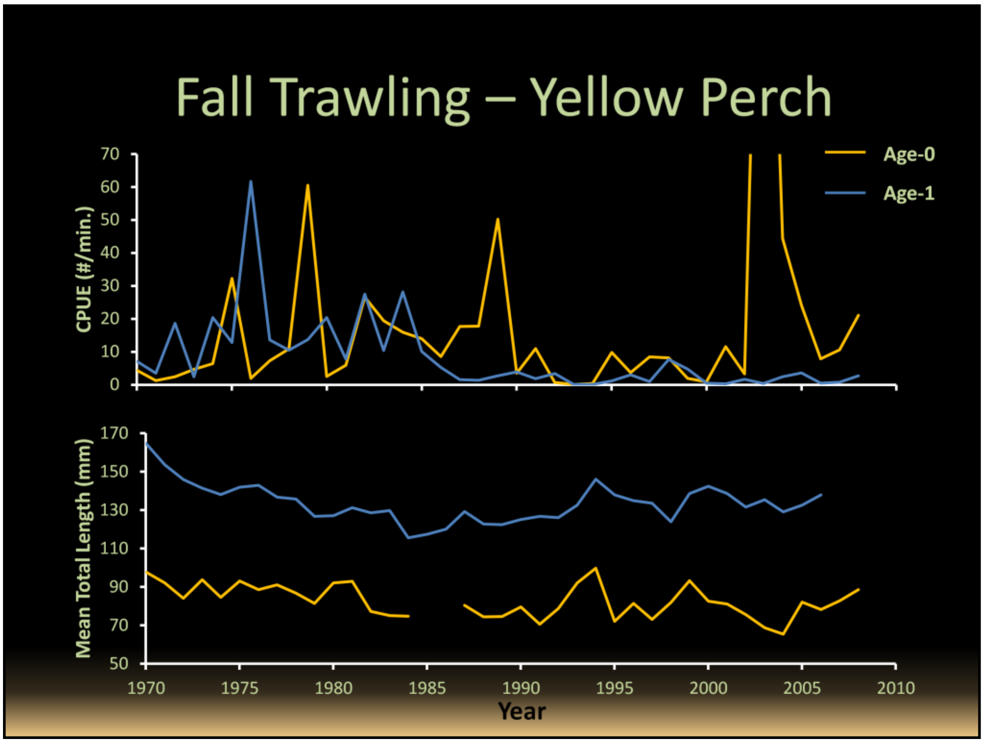
This is an overview of the juvenile and adult fish sampling (offshore). We used bottom trawls to collect these fish. We sampled once a month. Sampling in 2010 was a little less consistent than it was in 2009 due to boat availability. The circled sites on the maps are the 4 sites used in most of the following analyses; we also sampled at SB-20, but only caught fish there in the fall months.

I am now going to go over a presentation I gave at the Midwest Fish and Wildlife Conference a few weeks ago. I have added a few slides. This is the title slide.

The Saginaw Bay ecosystem has a history of change. Water quality has been influenced by pollution, nutrients, and sedimentation. Many invasive species have had dramatic influences on the food web. More recently, the Lake Huron alewife population crashed in 2003. This coincided with a sudden increase in production of age-0 yellow perch and walleye (as indexed by MDNR fall trawling surveys).



This slide shows the trends in fall trawling catch per unit effort (top graph) and mean length (bottom graph) for age-0 yellow perch (graphs made by Lori Ivan). Note the very high peak on the right side of the top graph; that is 2003. After 2003, young perch abundance has generally remained above the long-term average. These higher catches have been accompanied by smaller sizes, probably indicating density-dependent processes.

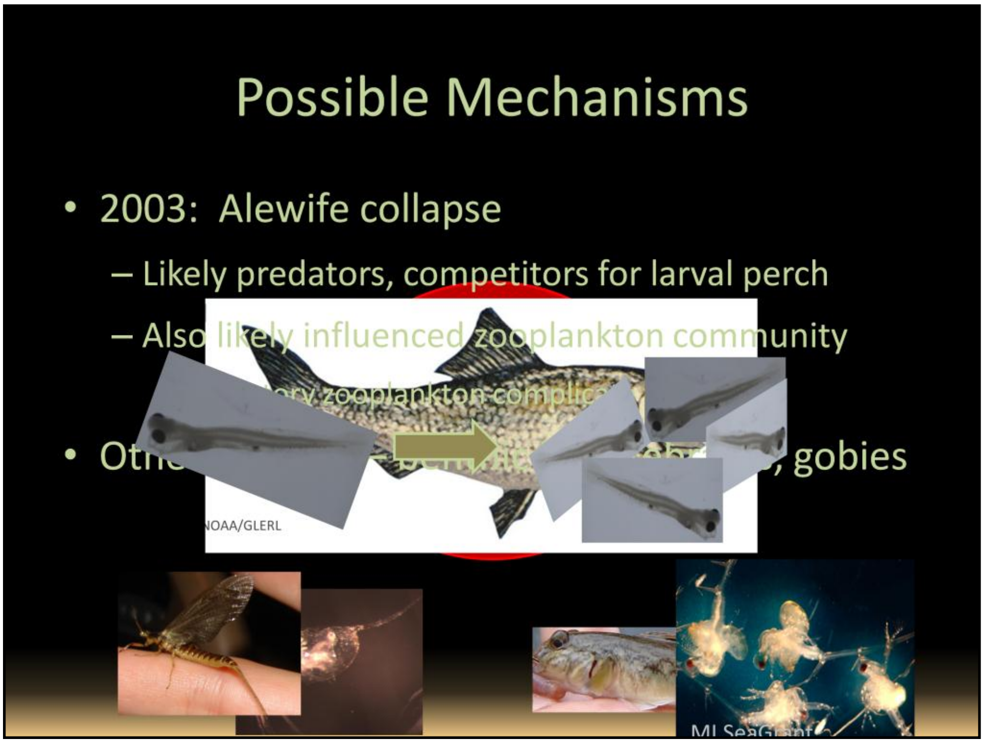


These are the same graphs as the previous slide, with trends for age-1 yellow perch added (scales are changed to make these trends visible). Early in the time series, high catches of age-0 fish often translated into high numbers of age-1 fish the following year, but high catches have not translated into more age-1 fish in recent years.

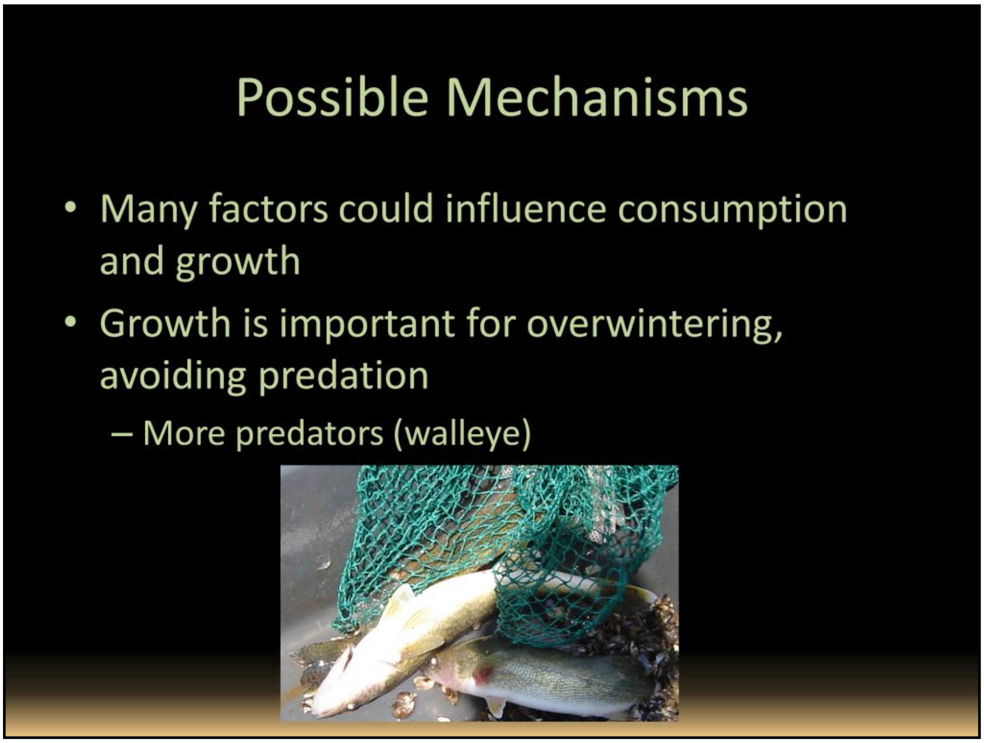
Saginaw Bay: a Changing Context

- Pollution, nutrients, sediment
- Invasive Species
- 2003: Alewife collapse
- Sudden increase in age-0 walleye and yellow perch production
- No increase in recruitment for yellow perch

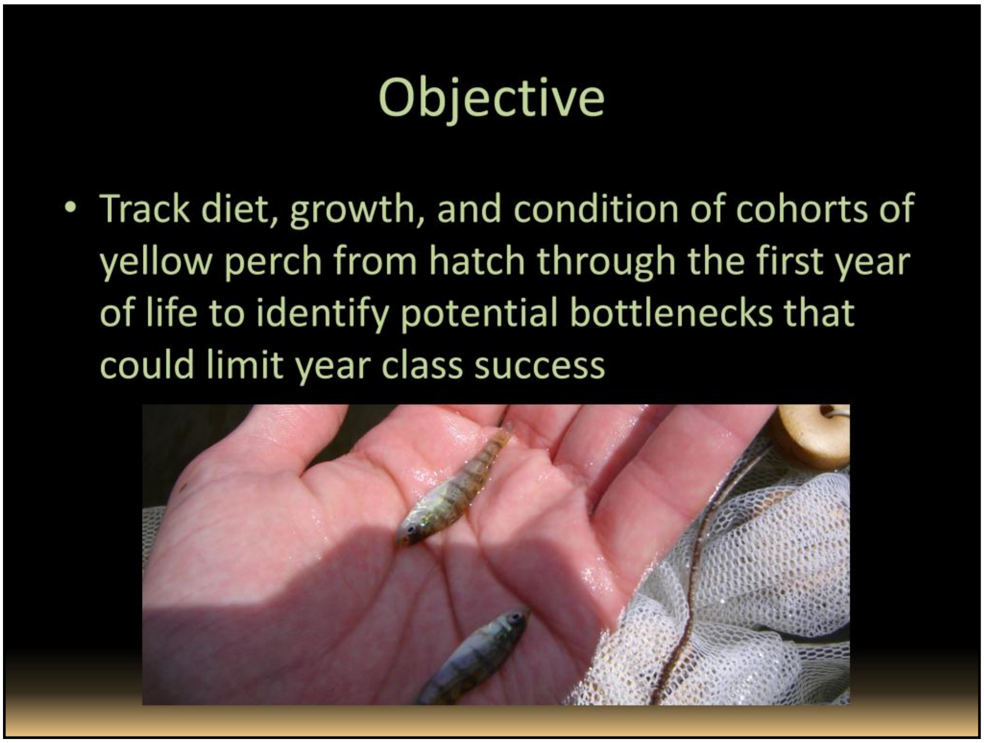
As indicated on the previous slides, there has been no increase in recruitment for yellow perch in this period of high age-0 production.



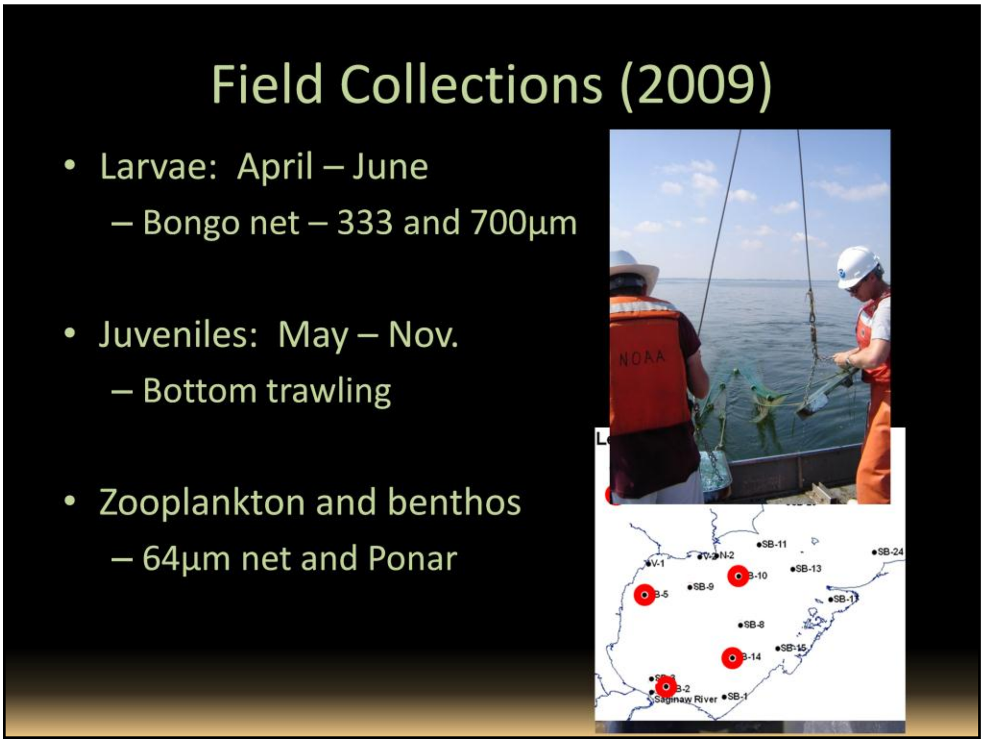
The alewife collapse in 2003 could potentially have influenced young perch in many ways. Alewives likely preyed on larval perch and competed with young perch for zooplankton prey. As a result, we would expect more larvae to survive, but this could lead to density-dependent reductions in growth. Alewives also are known to structure zooplankton communities, so in their absence we might expect more abundant, larger zooplankton. However, the presence of predatory zooplankton (especially invasive Bythotrephes) likely complicates things, since they might be more abundant in the absence of alewives, increasing predation on grazing zooplankton. Other changes have also occurred in the bay that might limit the ability of perch to grow. Benthic communities have changed with the introduction of zebra and quagga mussels, and *Hexagenia* mayflies are still rare in the bay. Invasive round gobies might also aggressively compete with young perch for benthic prey.



As illustrated in the previous slide, may factors could be influencing consumption and the resulting growth of young yellow perch in Saginaw Bay. Growth is important for young perch so they can have energy reserves to survive winter and so they can spend less time at sizes vulnerable to predation. This is especially important in the current bay ecosystem, since walleyes have become much more abundant.

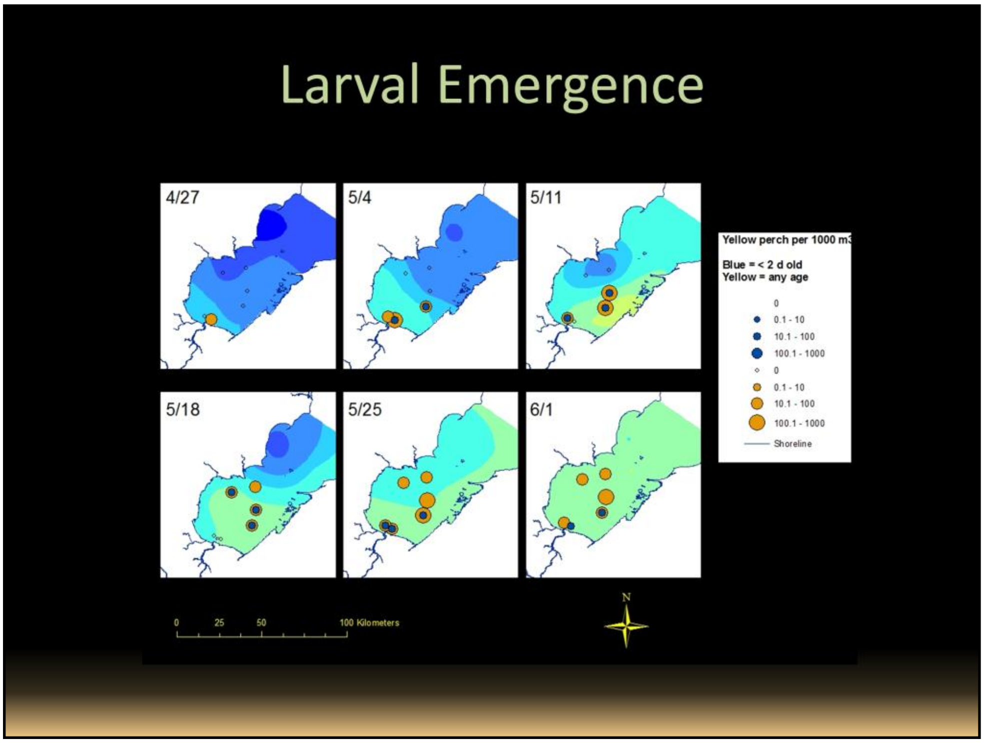


My objective was to track cohorts of perch from hatch through the first year of life and into the following spring to elucidate early-life mechanisms that could be influencing recruitment.

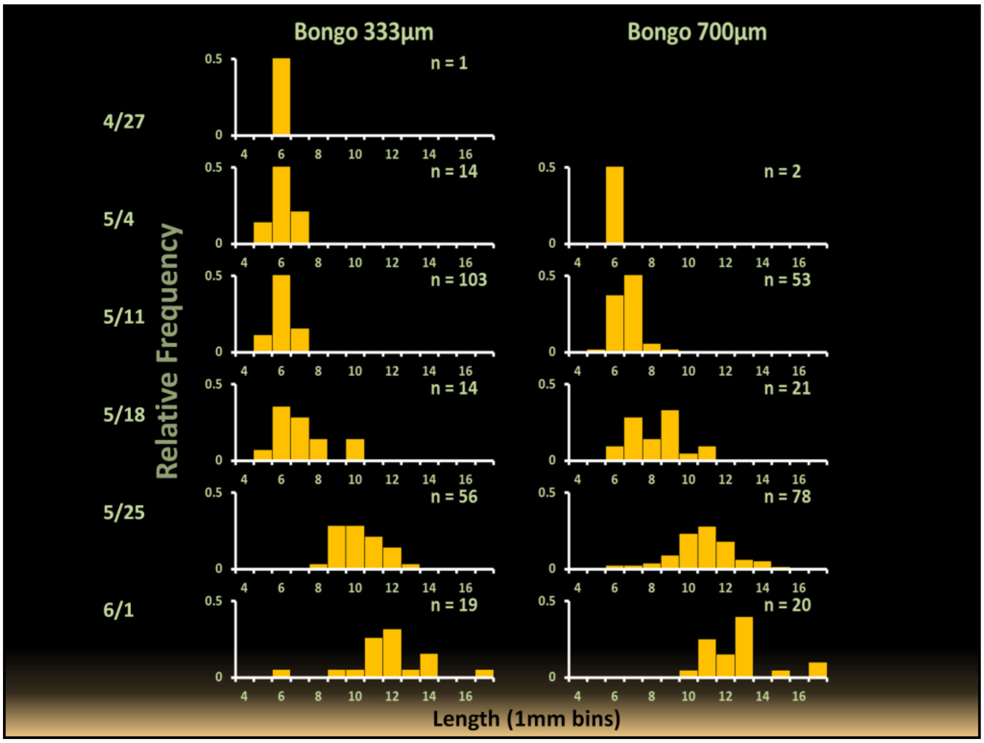


I conducted fieldwork to collect the samples needed. Larvae were collected weekly, juveniles monthly. Zooplankton prey were sampled at each site each time we sampled. Benthic prey were sampled at each trawling site once per month. The map shows the 4 trawling locations used for analyses in this presentation. Adult walleyes (predators) and other fish were also collected from the bottom trawls.

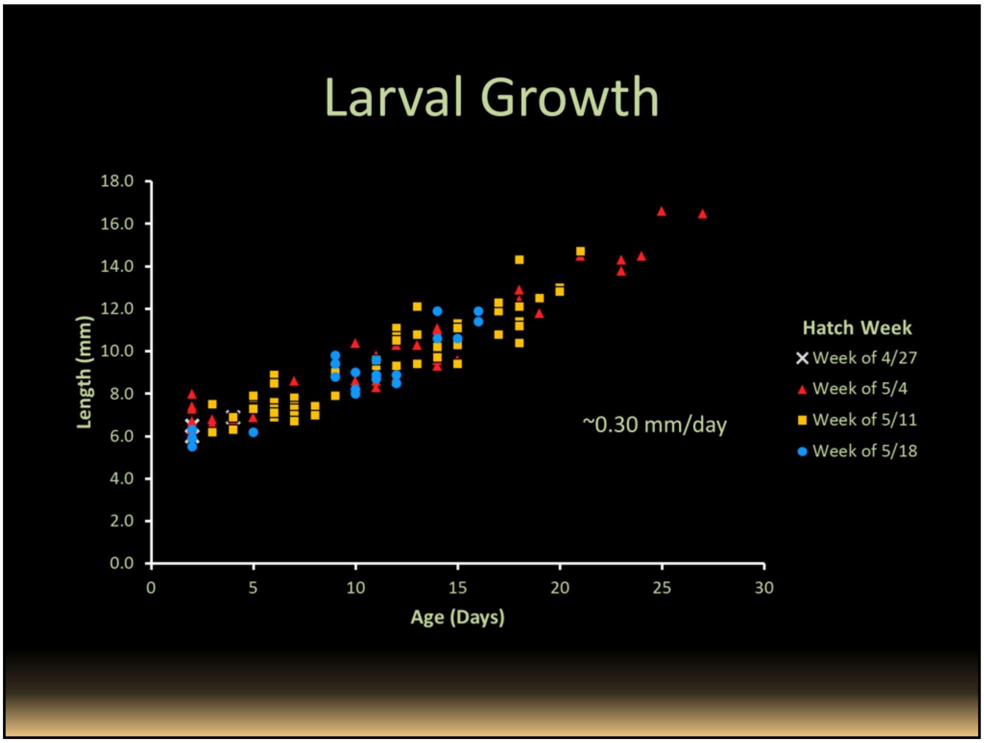
This slide explains the processing of my samples. In addition to what was already mentioned, I also measured wet and dry weight of juvenile perch as an index of condition (high energy content should equal high dry weight per gram wet weight).



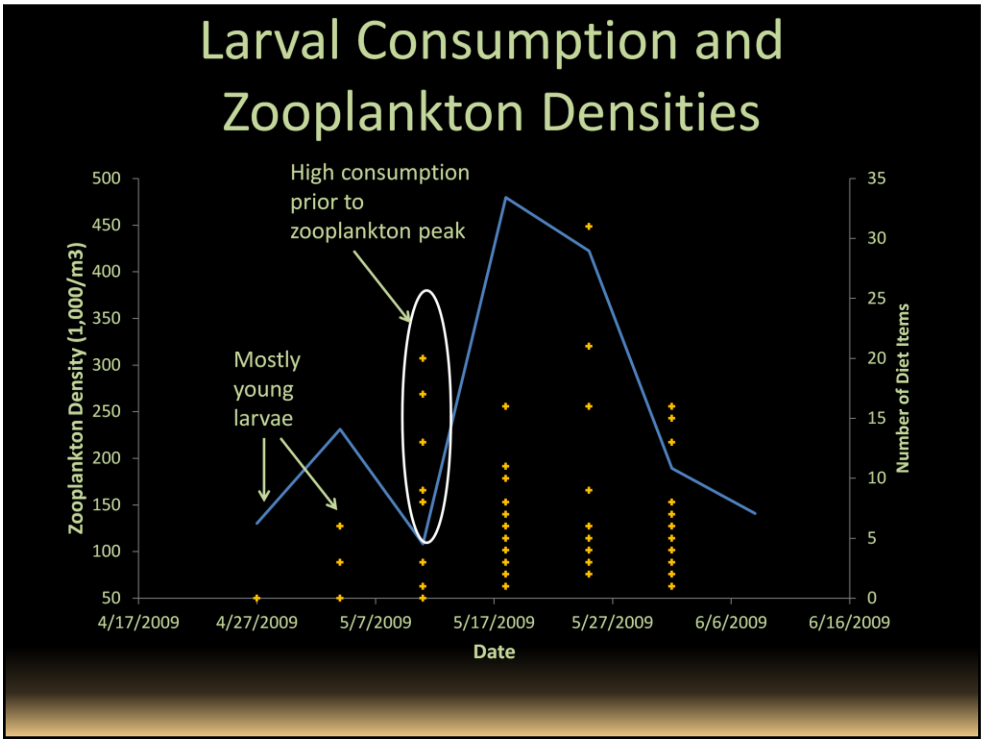
There are three things going on in this graph from 2009 data. The shading represents temperature; blue is cool and yellow is warm. The orange circles represent density estimates (bigger equals more fish) for all yellow perch larvae. The blue circles represent perch less than 2 days old (newly-hatched), roughly indicating locations near spawning sites.



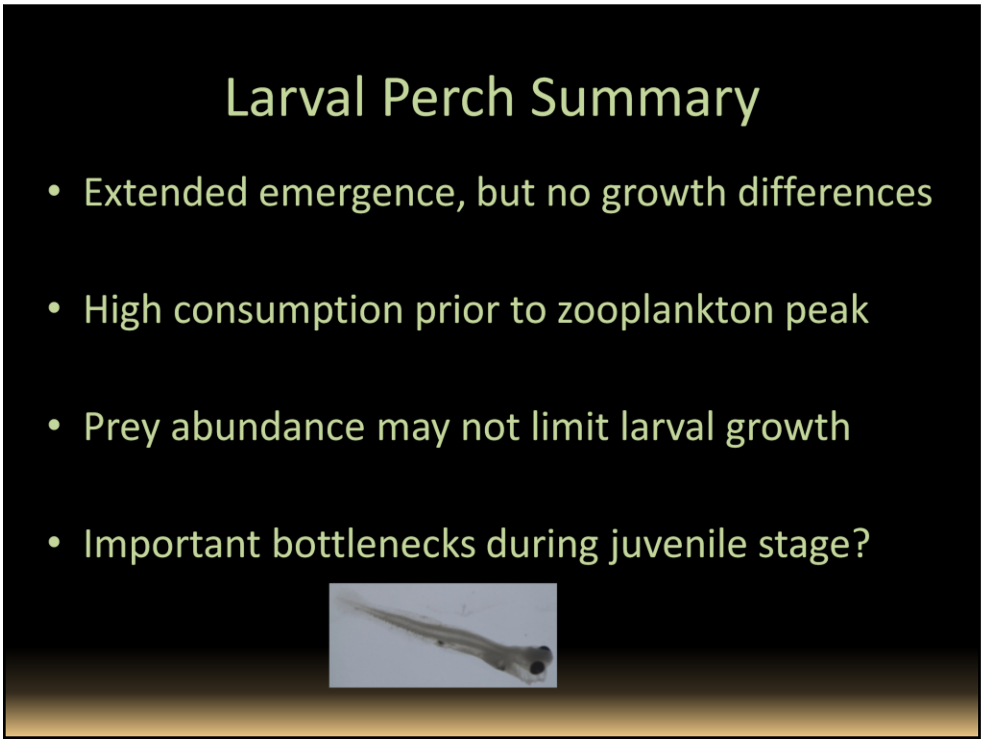
These are length frequency histograms for larval perch caught in each side of the bongo net in 2009. Both mesh sizes exhibit similar patterns. The lack of increase in mean size for the first few weeks likely reflects the fact that many yellow perch were hatching and recruiting to the left side of the distribution. Later in the period, size increases as larval emergence slows. It is important to note that size ranges are likely influenced by gear selectivity, as 15-17mm was the upper limit to the sizes of perch larval sizes that were vulnerable to the gear (larger larvae can avoid capture).



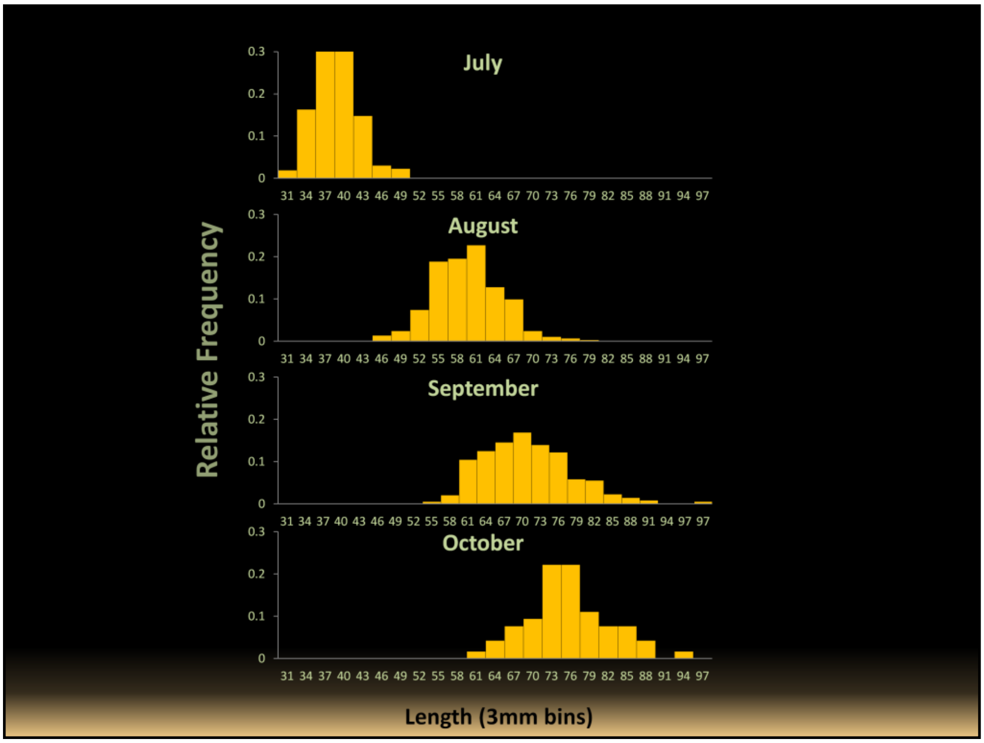
Here I plotted total lengths of measured perch larvae (from 2009) against their ages in days (determined by counting growth increments on otoliths). I plotted each week of hatch in a different color. Hatch date was calculated by subtracting the age at capture from the date of capture. There are no obvious differences in growth between early and late hatching larvae. A linear regression fitted to these data gives a slope of about 0.3mm per day, which is on the slow side for larval perch (from what I can find in the literature). However, the relatively cool temperatures in the spring of 2009 likely contributed to this slow growth.



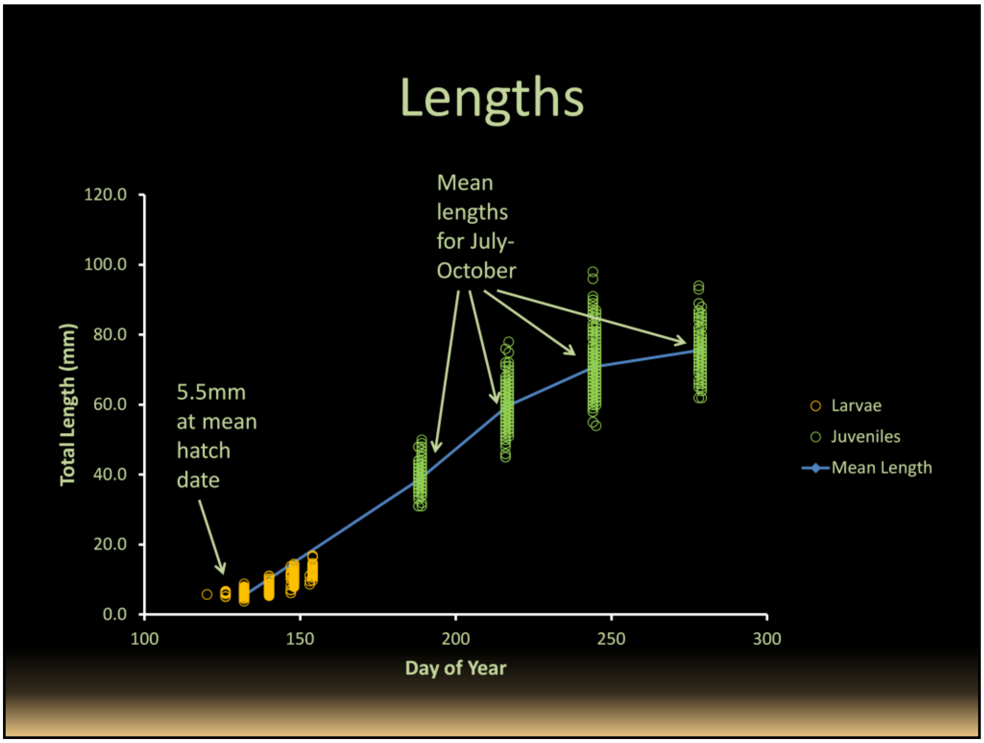
This is a qualitative way of looking at whether consumption by larval perch was limited by prey abundance. The blue line represents total zooplankton densities in the bay. The yellow dots indicate number of prey items consumed by larval perch. Yellow perch captured in the first two weeks are newly-hatched larvae without the capacity for high consumption. However, in the third week, some individuals are consuming large numbers of prey items, similar to numbers consumed the following week during the peak of zooplankton abundance. This indicates that there is enough prey for high consumption by some larvae at all times, and prey abundance might not be limiting consumption.



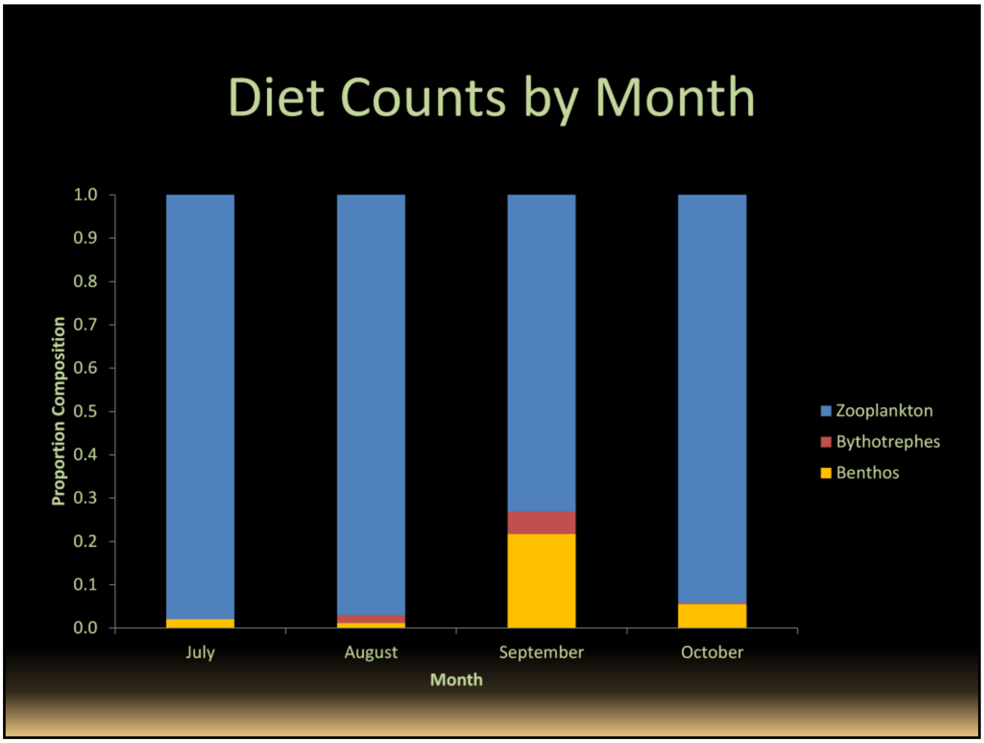
This slide summarizes the larval perch component. The larval perch data indicate that important bottlenecks might occur later in life, during the juvenile stage, which I'll discuss next.



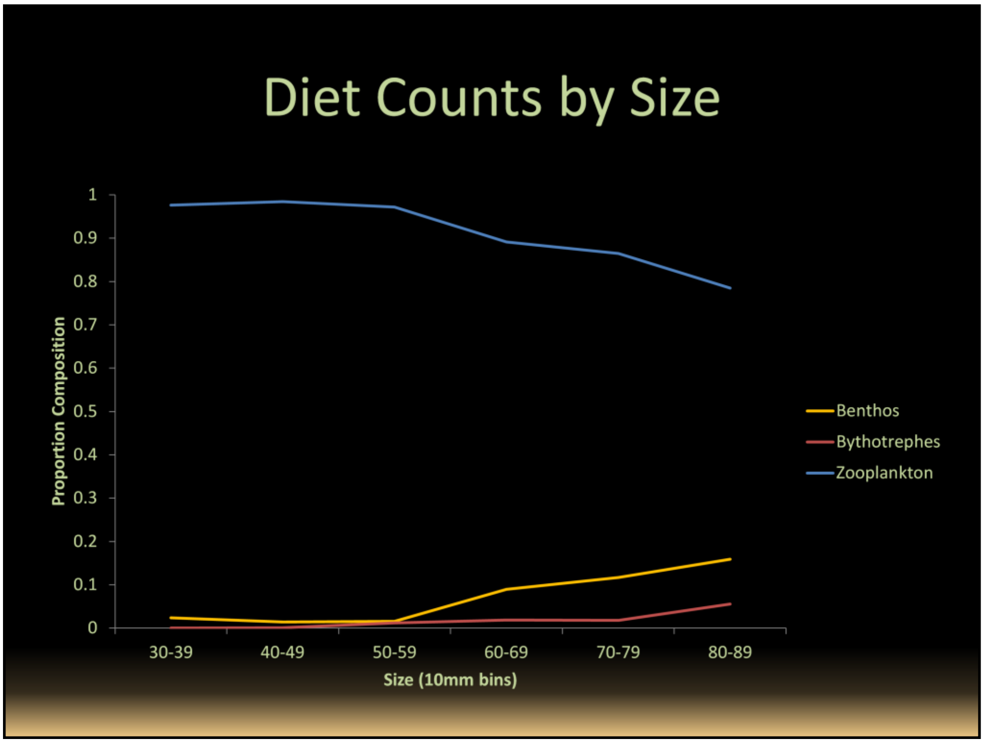
This slide shows length frequency histograms for age-0 yellow perch collected in bottom trawls. Prior to July, age-0 perch were small and not vulnerable to capture in the bottom trawls. Trawling was always conducted during the first week of the month. Note the big shift between July and October.



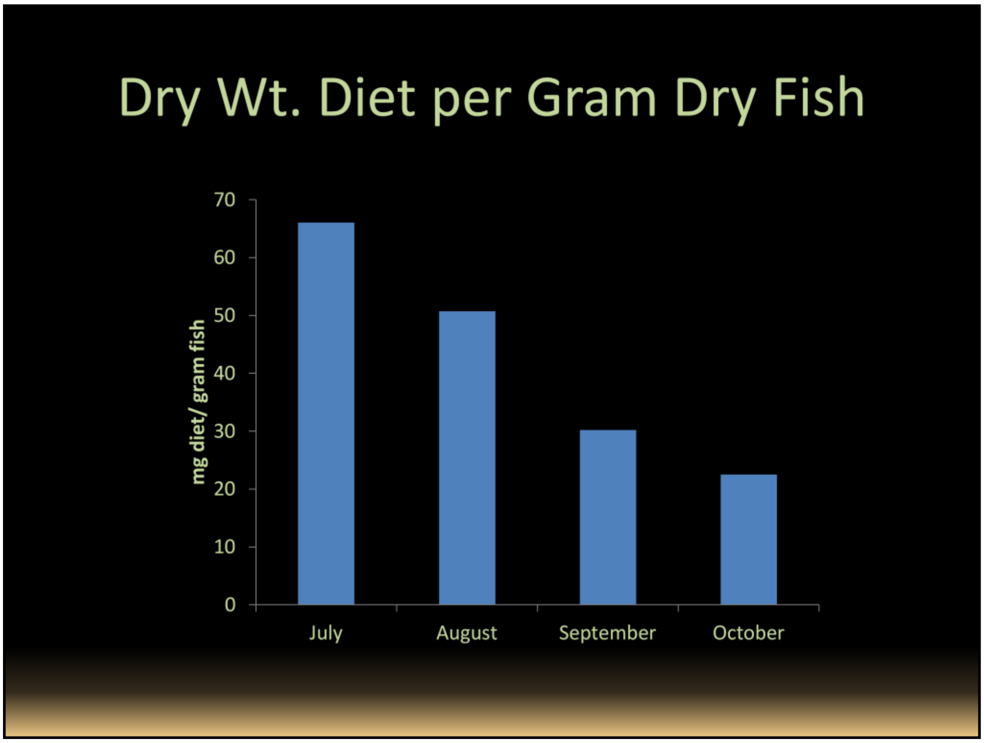
This is another way of looking at the length data, including larval lengths. The mean hatch date was calculated from ages of larval perch captured, and the mean hatch length of 5.5mm came from the literature (Auer larval fish key, 1982). The blue line follows mean lengths of perch in each month. Note that growth in length slows around September and October, despite temperatures relatively conducive to growth. Relative growth in weight (not shown) also slows during this period.



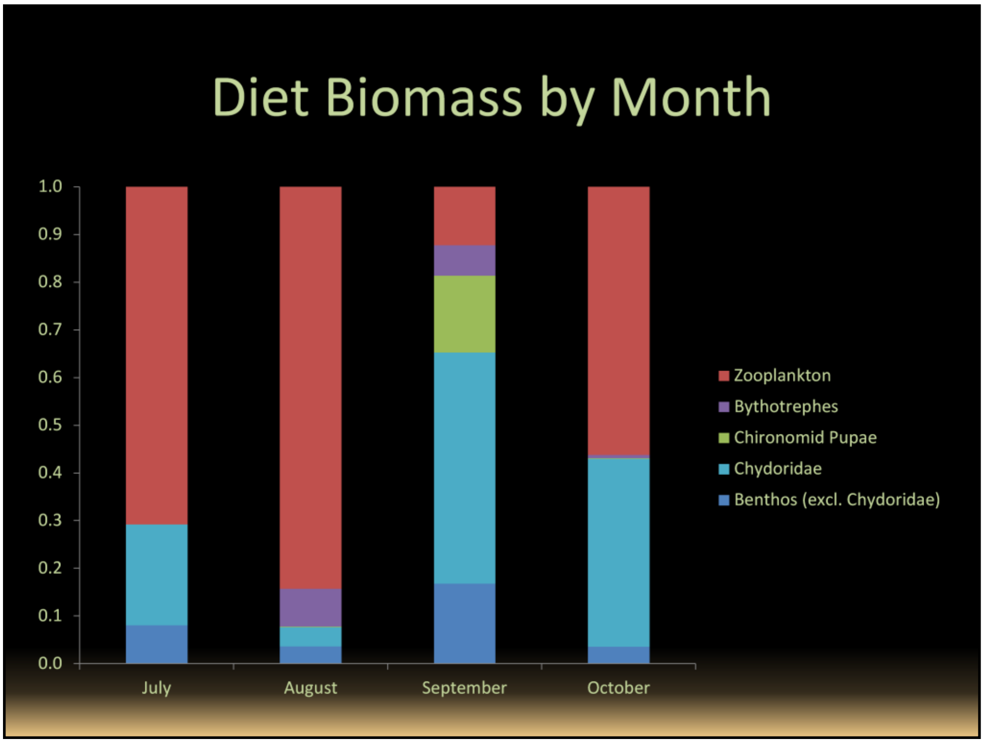
Diet could potentially explain patterns we saw in growth. This graph shows proportions of diets (by counts of items) for yellow perch in each month. Approximately 40 perch diets were analyzed for each month. Perch were consuming many zooplankton items and few benthic prey items, even late in the growing season. In many other systems, young perch switch to primarily benthos by the end of the growing season, or earlier in many cases.



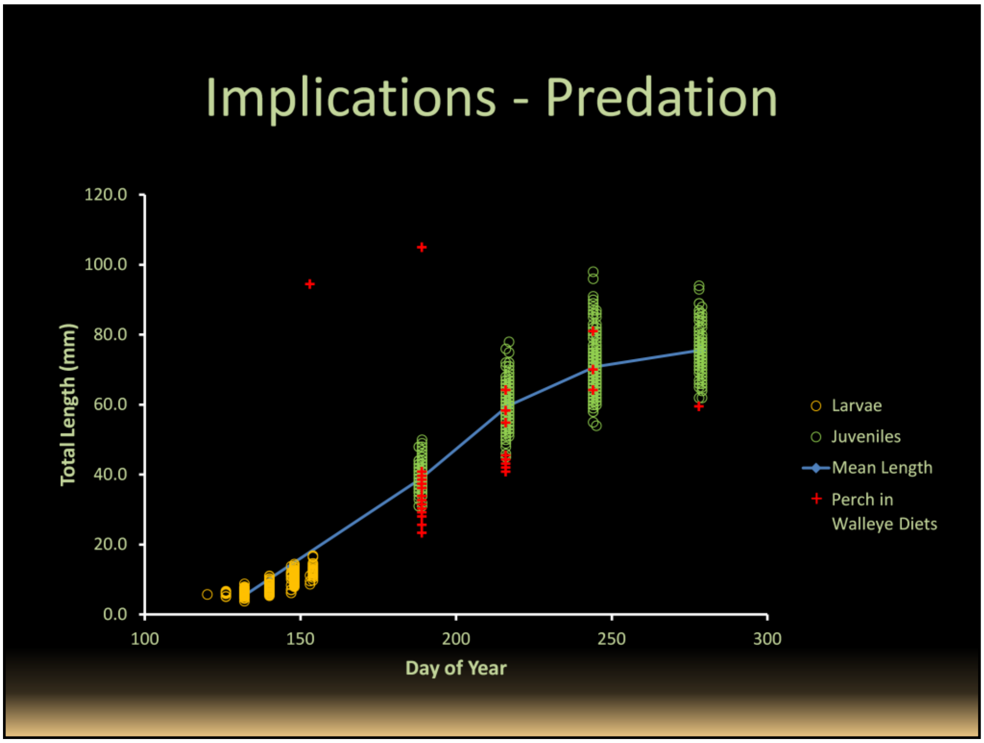
The previous graph included a range of sizes of perch for each month. Size likely also plays a role in diet shifts, so I plotted proportions of diet contents by size instead of month. The larger fish are eating benthic prey items, but zooplankton items still dominate diets, even for the largest individuals.



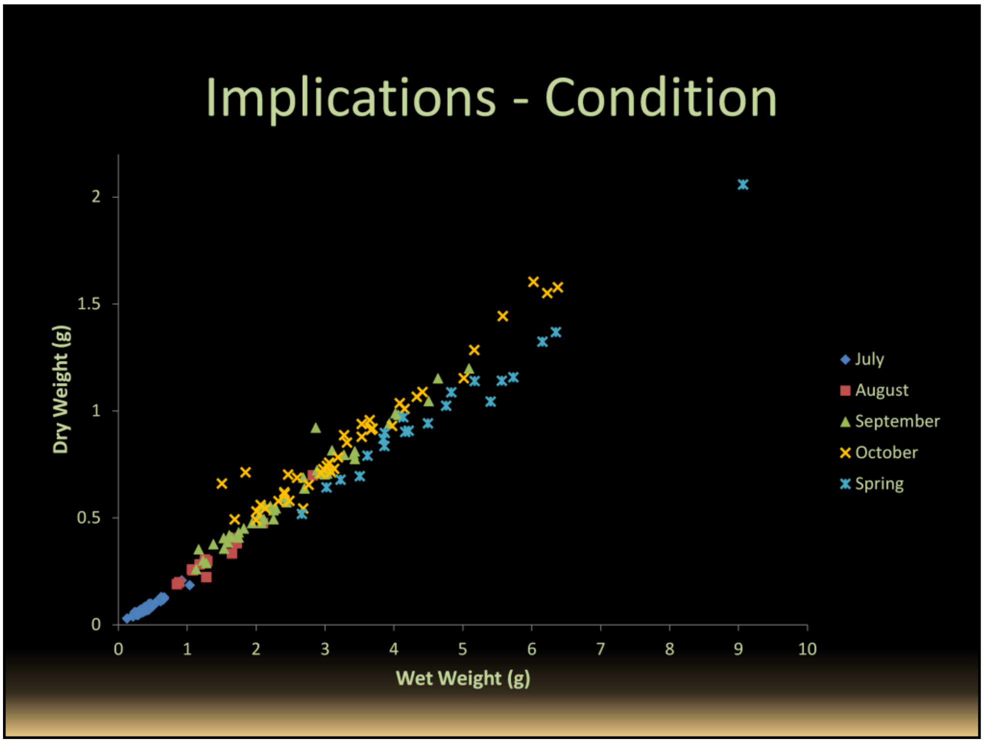
Counts of diet items don't tell the whole story. Dry biomass can also be informative, especially since it is related to total caloric content of diets. This graph shows the average dry weight of diets per gram of perch by month. Consumption per gram of fish decreases through the growing season, and this might relate to the slow growth seen in the later months.



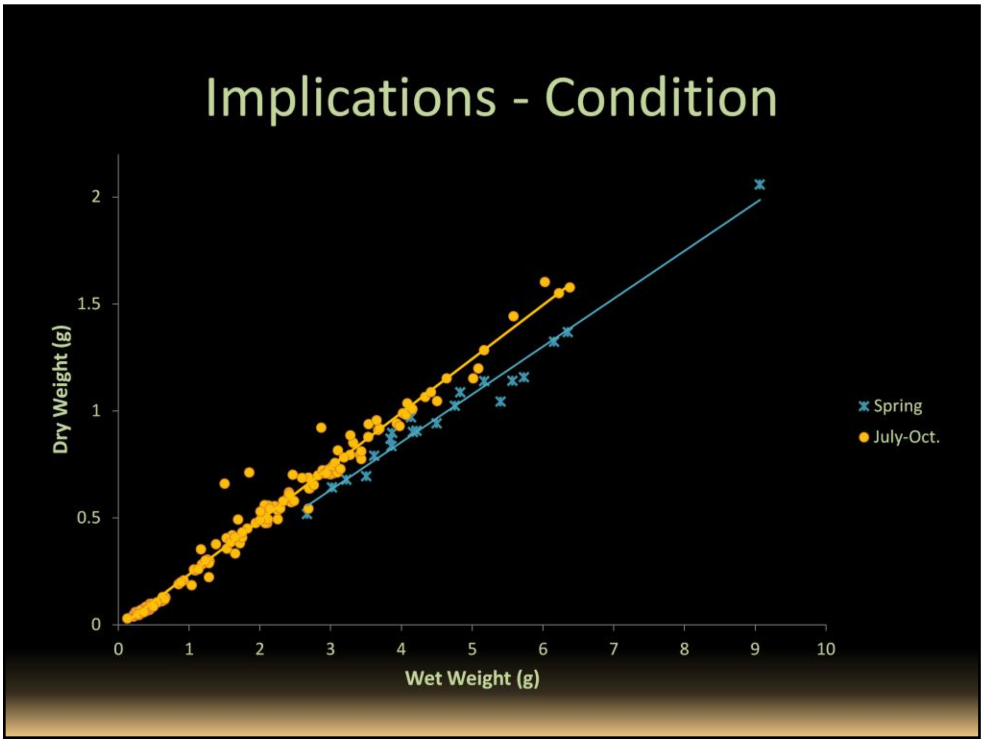
This graph shows proportions of diets (by biomass estimates of prey types) for yellow perch in each month. Approximately 40 perch diets were analyzed for each month. These estimates were calculated from counts of items and length-weight regressions for each prey type. After accounting for biomass of various prey items, benthic items appear more important later in the season. However, most of the benthic biomass consumed in September and October is from benthic cladocerans in the family Chydoridae. Since that prey type is composed of large numbers of mostly small individuals, the energy expended for search and capture of Chydorids likely means feeding habits remain relatively inefficient during these months. In addition, pelagic items (including Chironomid pupae, *Bythotrephes*, and other zooplankton) still comprise a substantial portion of yellow perch diets late in the year. Again, this differs from other systems (such as western Lake Erie), where perch often switch to feed nearly exclusively on benthic prey much earlier than October. Thus, patterns in young yellow perch diets may be contributing to the slow growth observed.



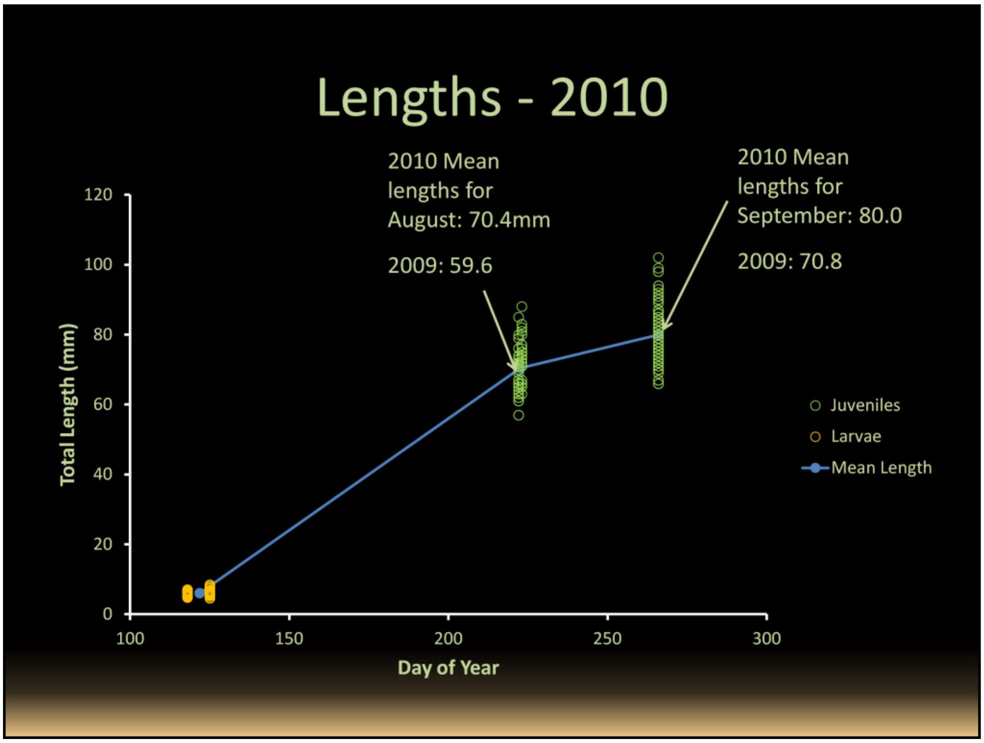
The next few slides discuss implications for slow growth (possibly caused by diet patterns). The red points are lengths of yellow perch we found in walleye diets (from our bottom trawls). Although some walleyes have the capacity to eat larger prey (for example, the age-1 perch seen in the two high points during June and July), the smaller individuals of the age-0 cohort seem to be targeted. Therefore, it benefits perch to grow fast to reduce the risk of predation.



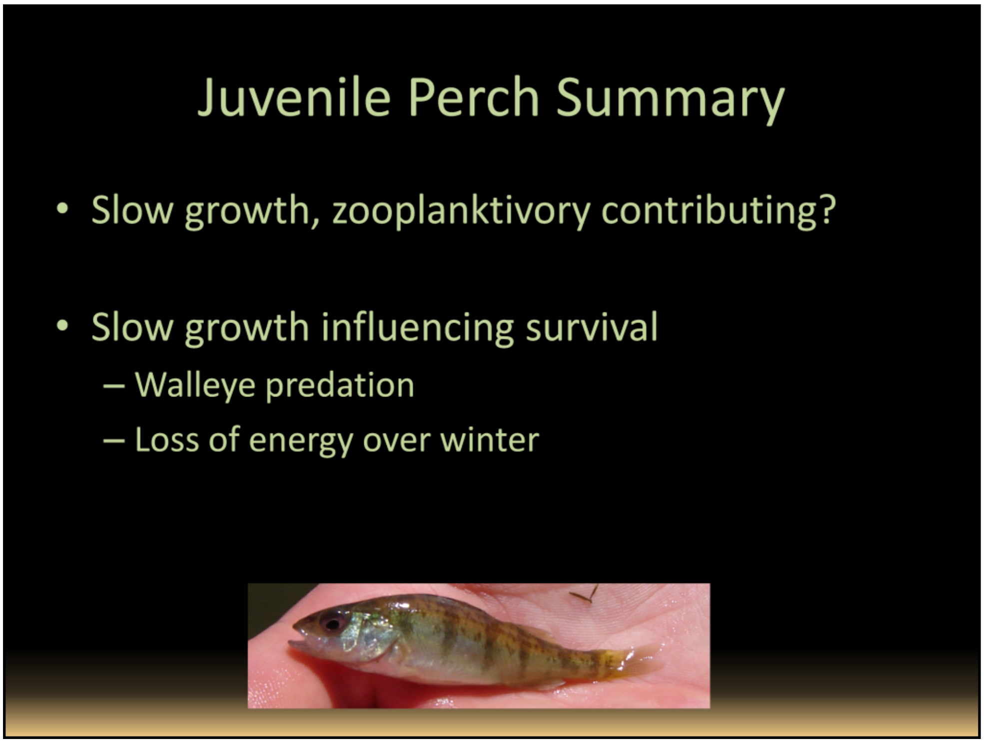
In this graph, I plotted dry weight against wet weight of individual age-0 yellow perch. This is a rough index of condition, since perch with a high energy content should have a higher dry weight per gram of wet weight. The two important groups of points on this graph are the orange points (October fish just prior to winter) and the light blue points (spring fish just after winter). Note that the smallest individuals (wet weight) are lost over winter.



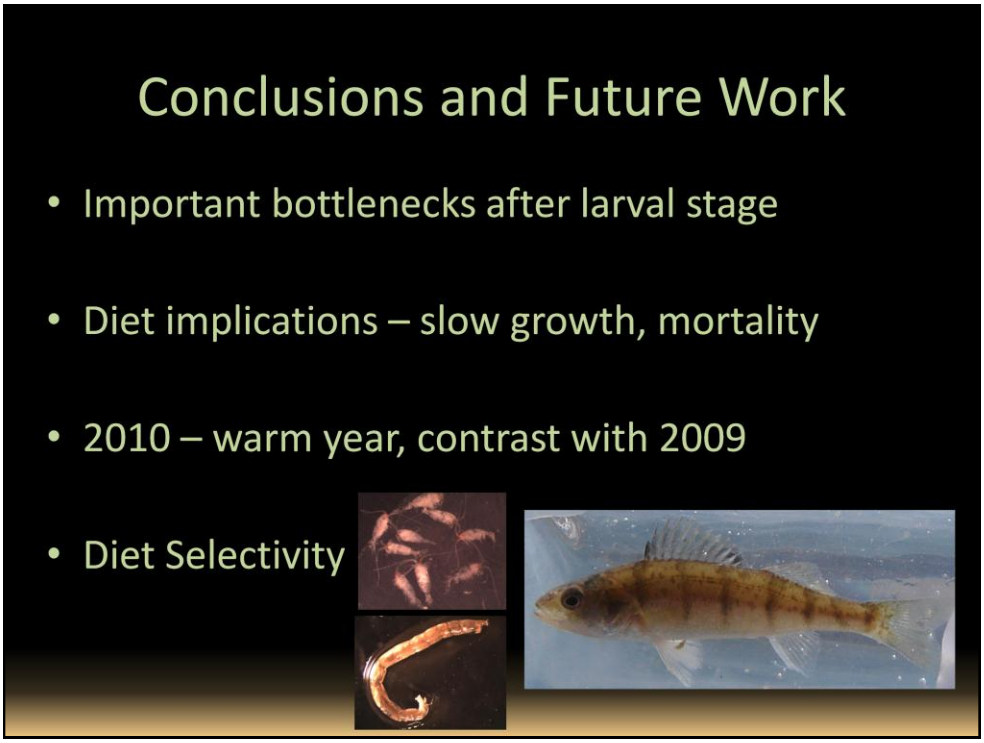
This graph shows the data from the previous graph, with all the points from the first growing season grouped together. Note the downward shift from the first growing season to the following spring (i.e. a lower intercept). This indicates that perch are losing energy reserves over winter, which may be why the smaller individuals in October (seen on the previous graph) appear to be missing in the spring. Thus, starvation is another potential implication of slow growth.



This shows the preliminary data we have so far for 2010. In 2010, larvae were abundant slightly earlier than in 2009. Mean sizes of juvenile perch were larger in 2010. The trawling dates were somewhat later in 2010, but it is still apparent that growth was faster, since the mean length for August in 2010 approached the mean length for September 2009 (~3 weeks later in the year). The earlier hatch dates and faster growth are likely both related to the much warmer temperatures present throughout much of 2010. Growth again appears to slow by September.

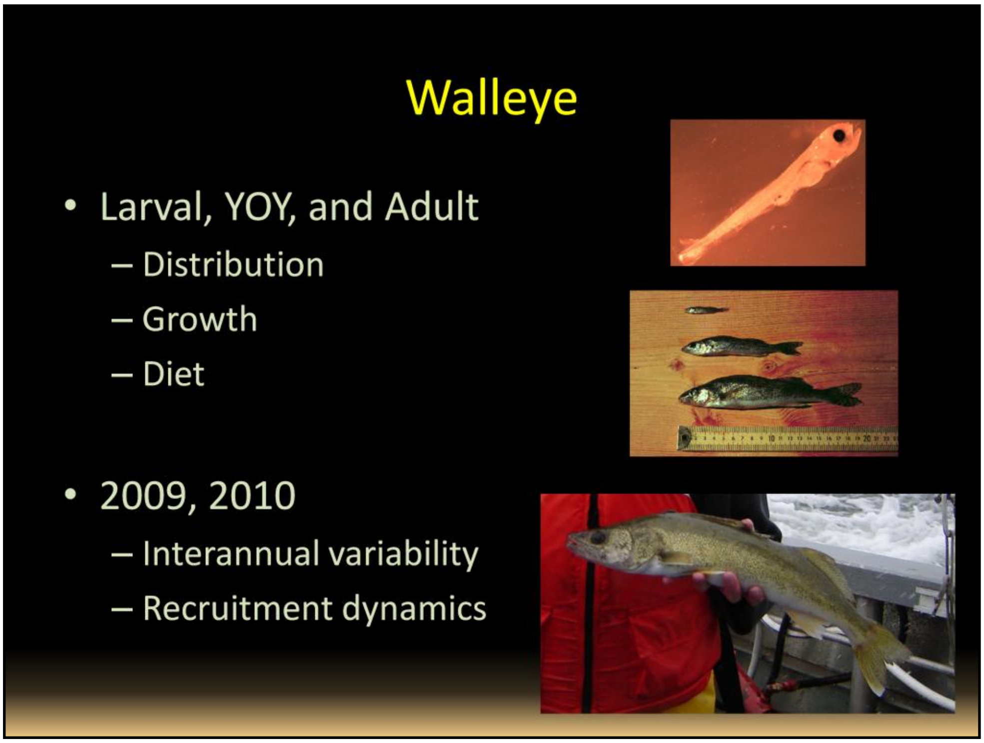


This slide summarizes the juvenile aspect of the age-0 yellow perch work. A high degree of zooplanktivory late in the growing season might be contributing to the observed slower growth. In turn, this slow growth appears to increase mortality risk, through both walleye predation and loss of energy stores over winter. It is difficult from our data to determine the relative magnitude of each mechanism.

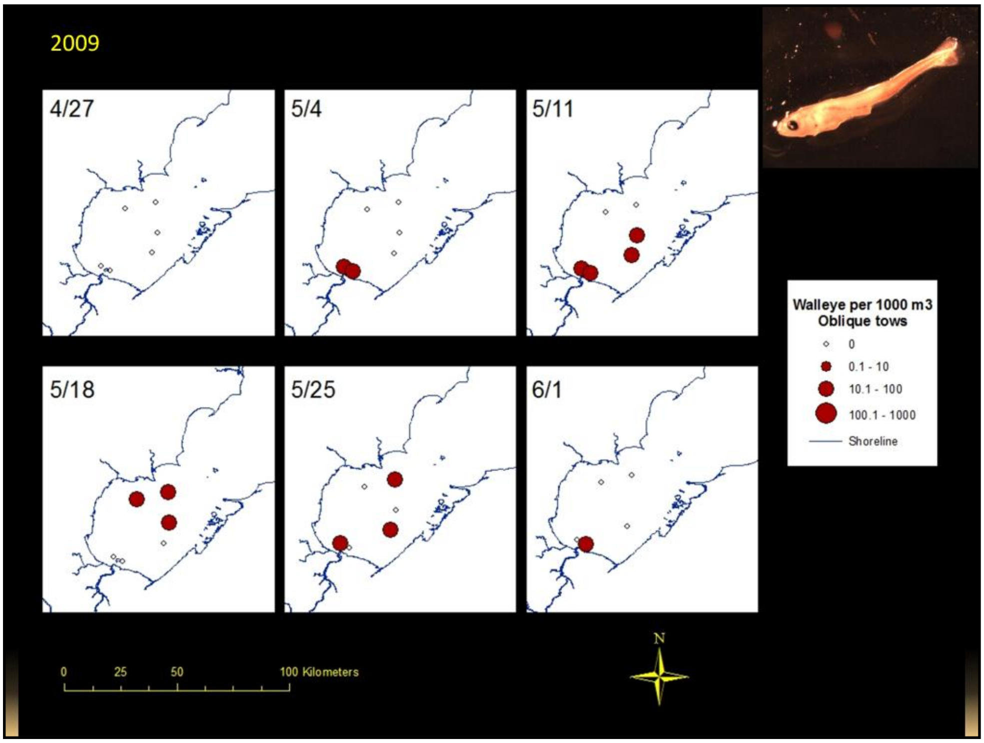


To conclude the young perch research so far, it appears that important bottlenecks for growth and diets exist after the larval stage. The observed patterns in young perch diets may result in slower growth (beyond density-dependent processes), leading to high mortality. 2010 provides a nice contrast with 2009, since 2010 was quite warm while 2009 was relatively cool. Our continuing work on perch growth and diets from both years could help determine whether bottlenecks limiting recruitment differ between years with different climate/weather conditions. Our future work will also include investigating diet selectivity of young perch by accounting for prey availability. This will help us determine whether young perch are eating large numbers of prey items only because they are abundant, or whether they are selecting for certain prey items, even when they are less abundant. In addition, we can compare diet composition with other factors, such as dreissenid mussel density or goby density at the time and location of capture for each perch. This may help us understand factors that might be leading to the observed patterns in perch consumption, which seem to be sub-optimal based solely on diet composition and growth.

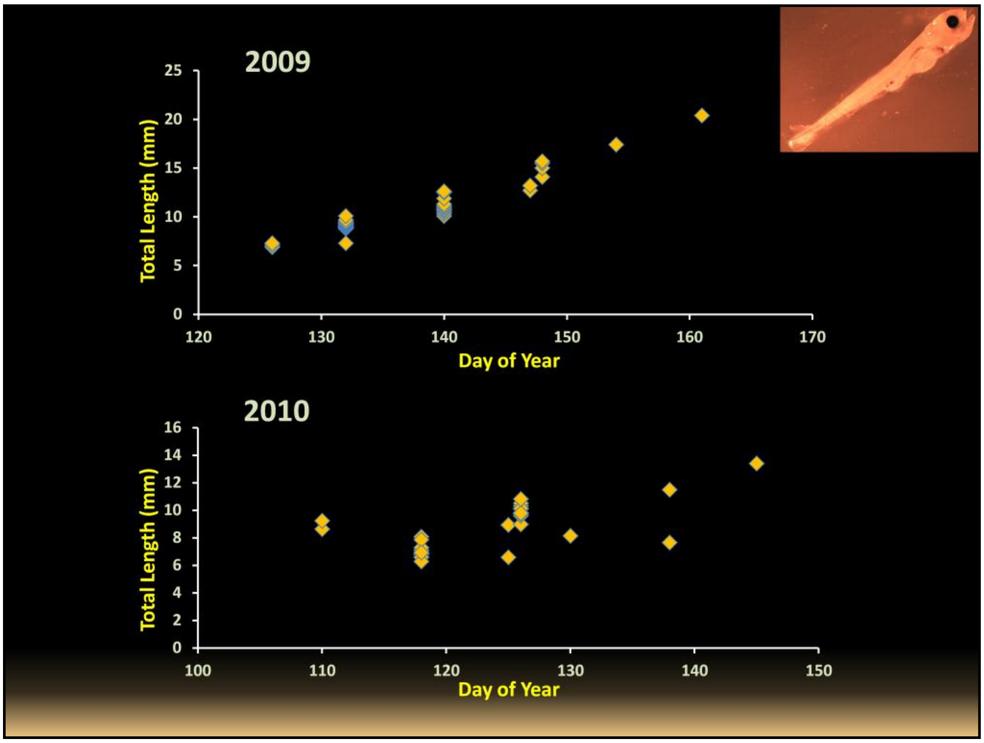
Acknowledgement slide from my Midwest FWC presentation. Includes people from Purdue, NOAA, MSU, and “Many others.”



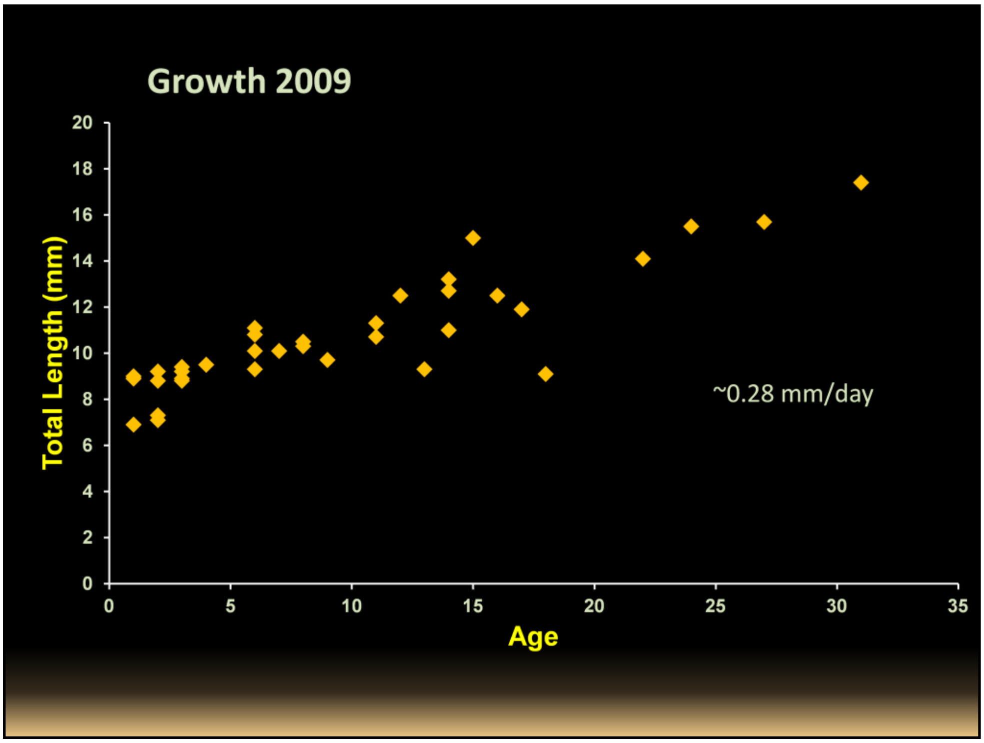
Walleye is another species of interest with ecological and economic importance. The walleye population has been recovering in Saginaw Bay over the last eight years. To assess walleye recruitment, we are measuring distribution, growth, and diet of walleye through their ontogeny.



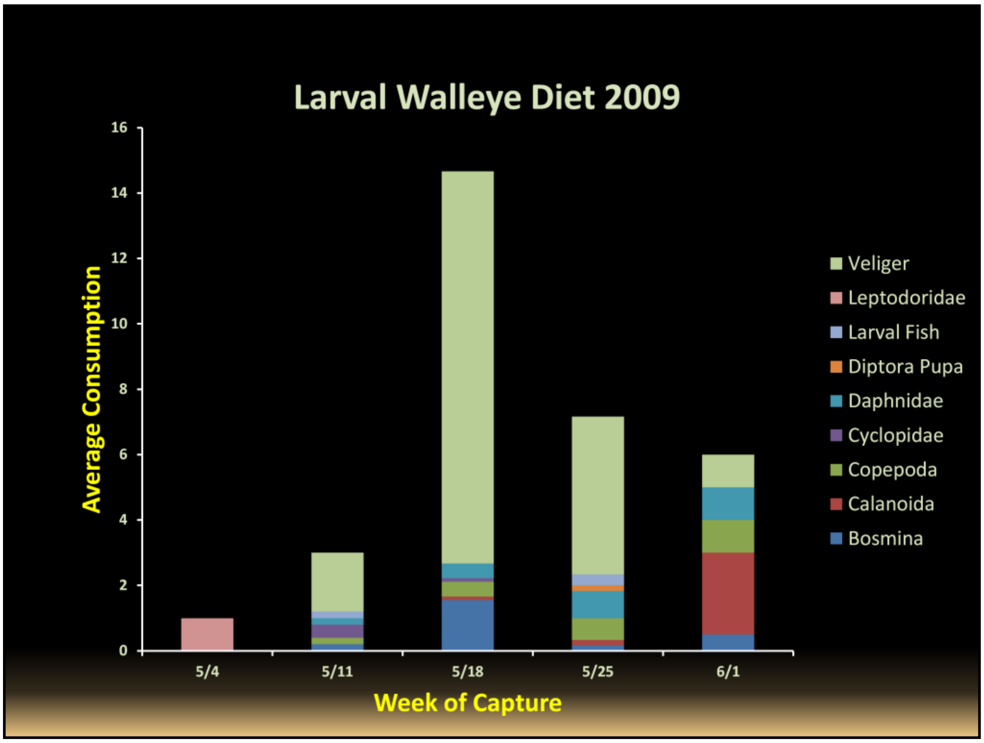
Total CPUE (333υm and 700um mesh) of larval walleye in 2009 at offshore core sites in oblique tows. In 2009, the majority of larval walleye were collected in oblique tows. Walleye appear to emerge first at the southern end of the bay near the river mouths. In 2010, a warmer year, larvae emerged two weeks earlier. We collected several small (<8 mm) walleye with large yolk sacks at sites 5 and 9. Site 5 and site 9 are removed larger river mouths and adjacent to historic hard substrate, reef areas.



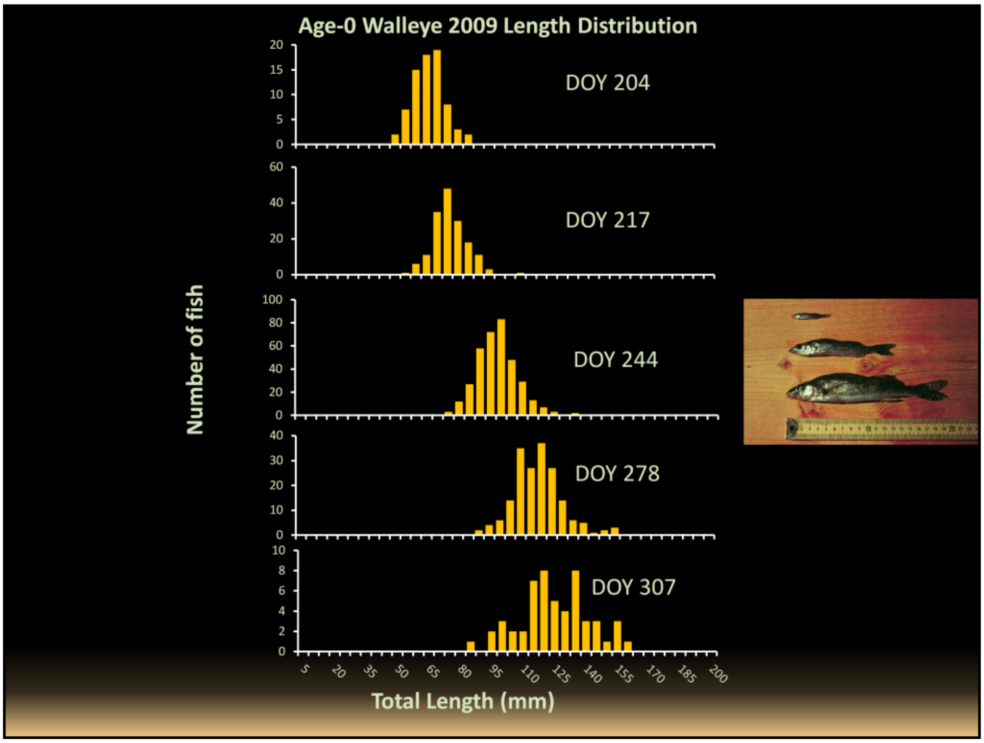
In 2009 there is a linear relationship between day of year and length of larvae; however, in 2010 the pattern is not as clear, which may indicate multiple spawning events or, potentially, multiple spawning locations.



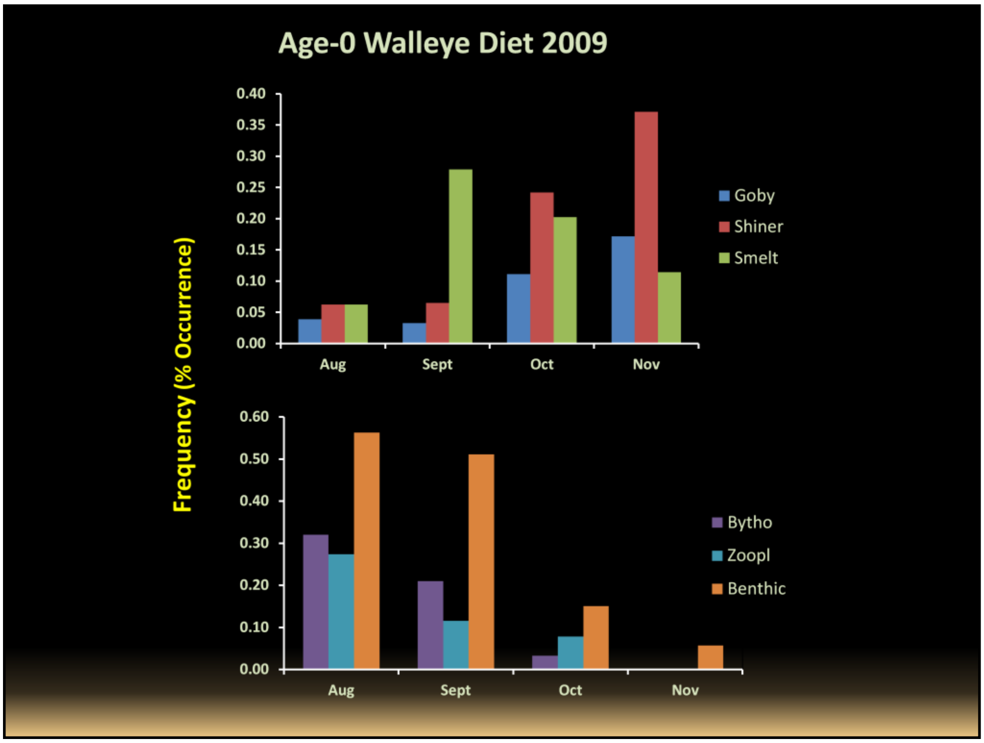
We extracted otoliths and aged walleye larvae from 2009. Using a linear regression model, larval walleye growth was estimated to be approximately 0.28 mm per day. This most likely underestimates their true growth rate. We expect many walleye greater than 20-days-old to be much larger than 18 mm and, therefore, not vulnerable to sampling gear. This growth estimate is biased due to gear selectivity.



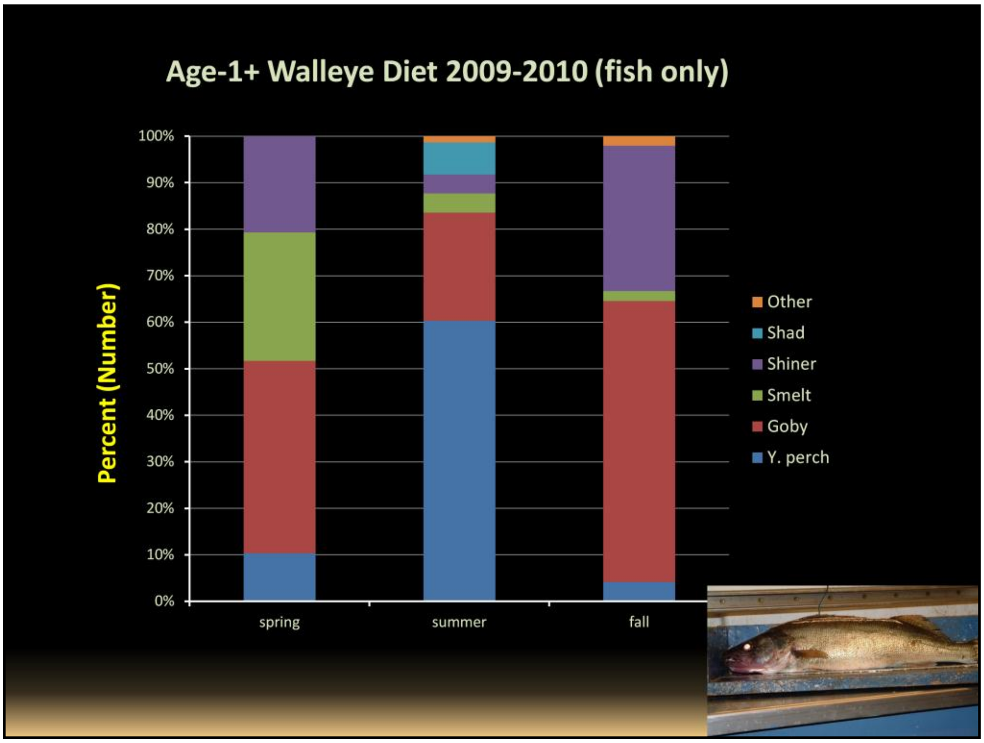
Larval walleye consume small zooplankton, especially veligers, and they switch to larger zooplankton, such as calanoid copepods, as they grow larger.



Age-0 lengths follow the expected trend. The gradual increase in length throughout the year is consistent with our determination that walleye are fully recruited at age-0.

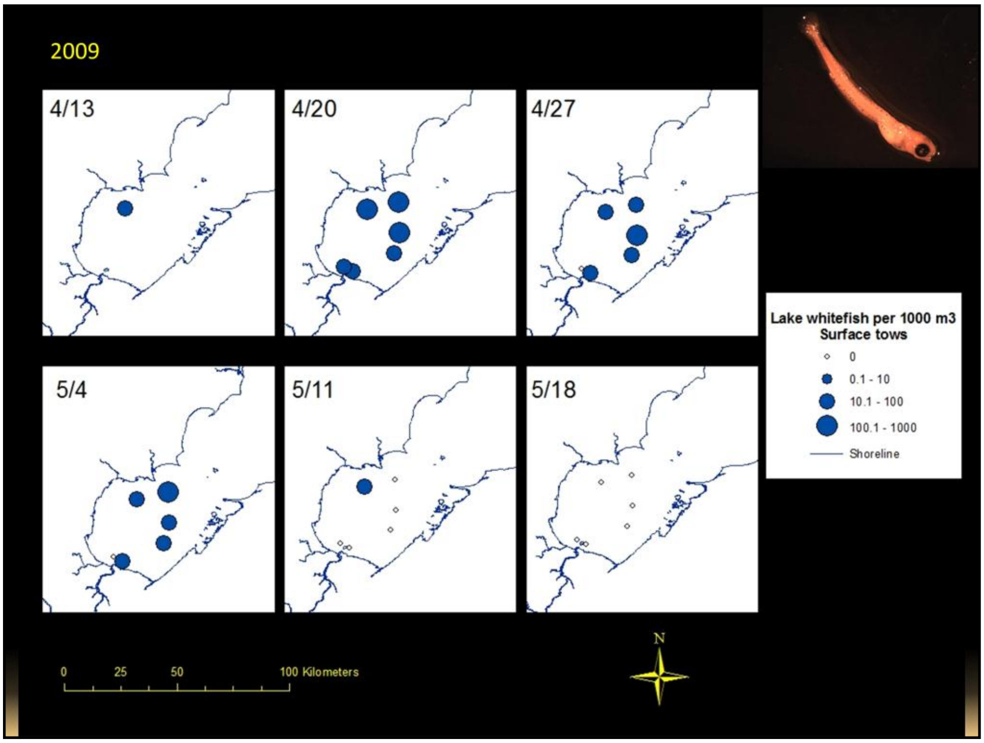


In summer, age-0 walleye consume more zooplankton and benthos, while in the fall they switch to piscivory.

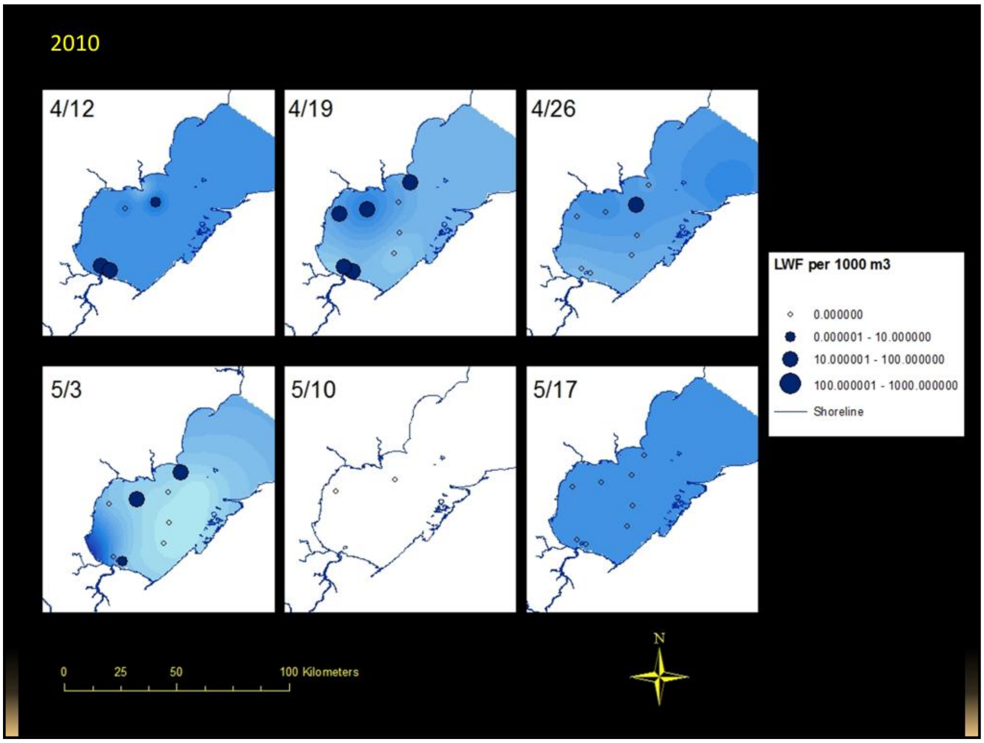


This summary largely depends on 2009 diet; few walleye were caught in 2010. Additionally, there were large numbers of pupae in diets in spring 2010. There is considerable seasonal variability in walleye diets with round goby and yellow perch composing large proportions among all three seasons.

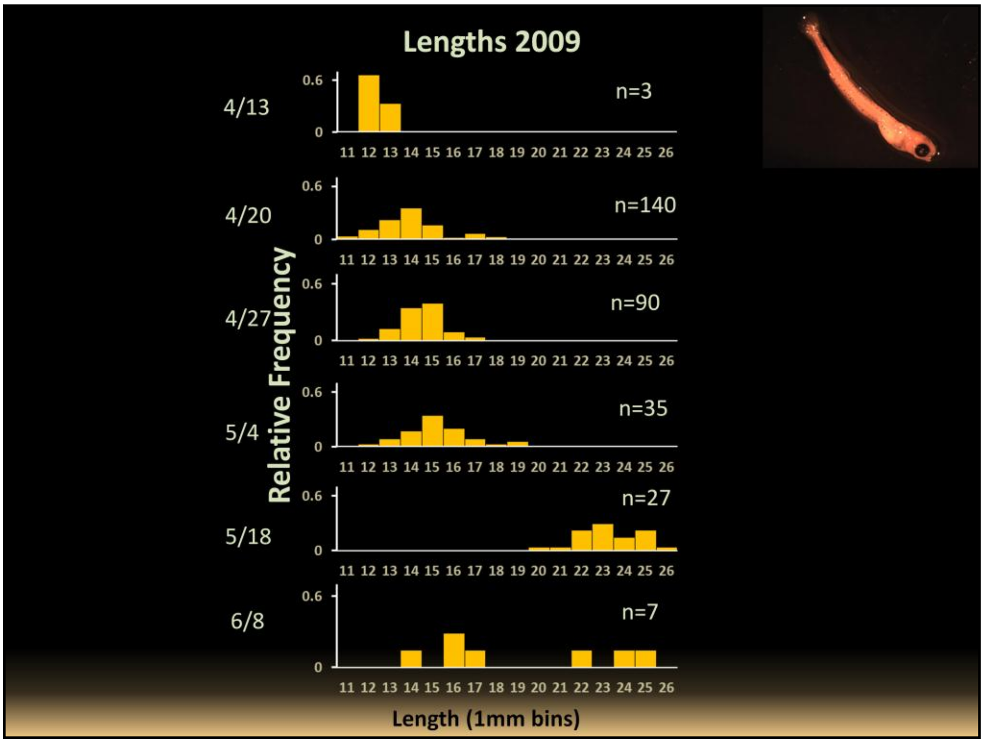
In addition to yellow perch and walleye, we are assessing distribution, growth, and diets of lake whitefish as indices of recruitment.



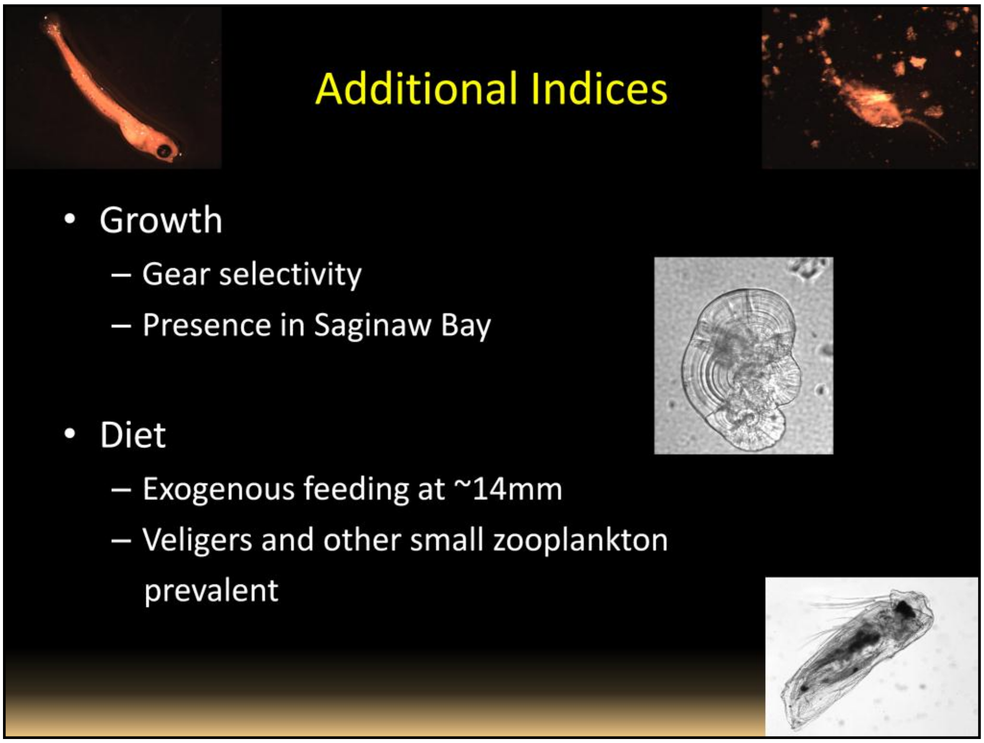
Total CPUE (both mesh sizes) of lake whitefish at offshore core sites in surface tows. The week of 4/13, only one site was sampled.



We are in the process of quantifying 2010 larval lake whitefish. Preliminarily, they seem to show a similar distribution in 2009 and 2010. In both years larvae are widely distributed spatially; however, it remains unclear whether or not they are spawning in multiple locations.

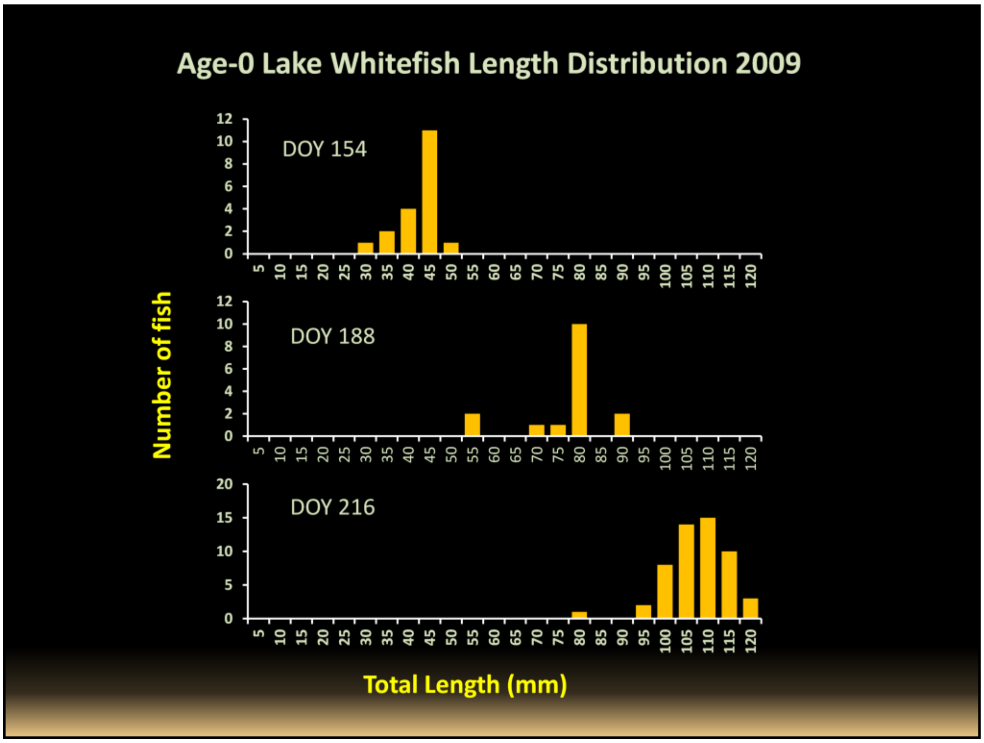


The lake whitefish larvae collected during the weeks of 5/18 and 6/8 were collected with the neuston net (1000um mesh). The smaller larvae collected during the week of 6/8 were collected at site 11, near the outer bay. Presumably these larvae were advected from Lake Huron, a colder environment conferring slower growth.

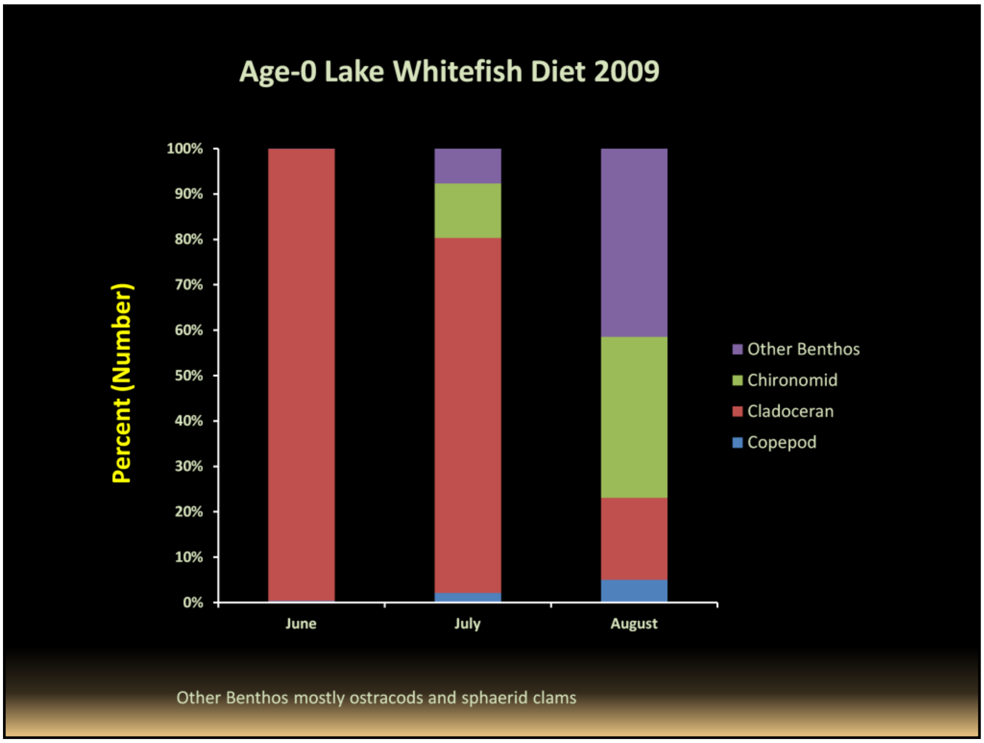


Measuring larval lake whitefish growth is challenging because they grow quickly and rapidly exceed sizes selected for by our gear. Larger larvae may also move outside of the sampling area.

Larval lake whitefish appear to switch from endogenous to exogenous feeding at approximately 14 mm, which is larger than expected. Veligers seem to be a large component of their diet.



Lake whitefish grow quickly in Saginaw Bay; in August many are greater than 110 mm.



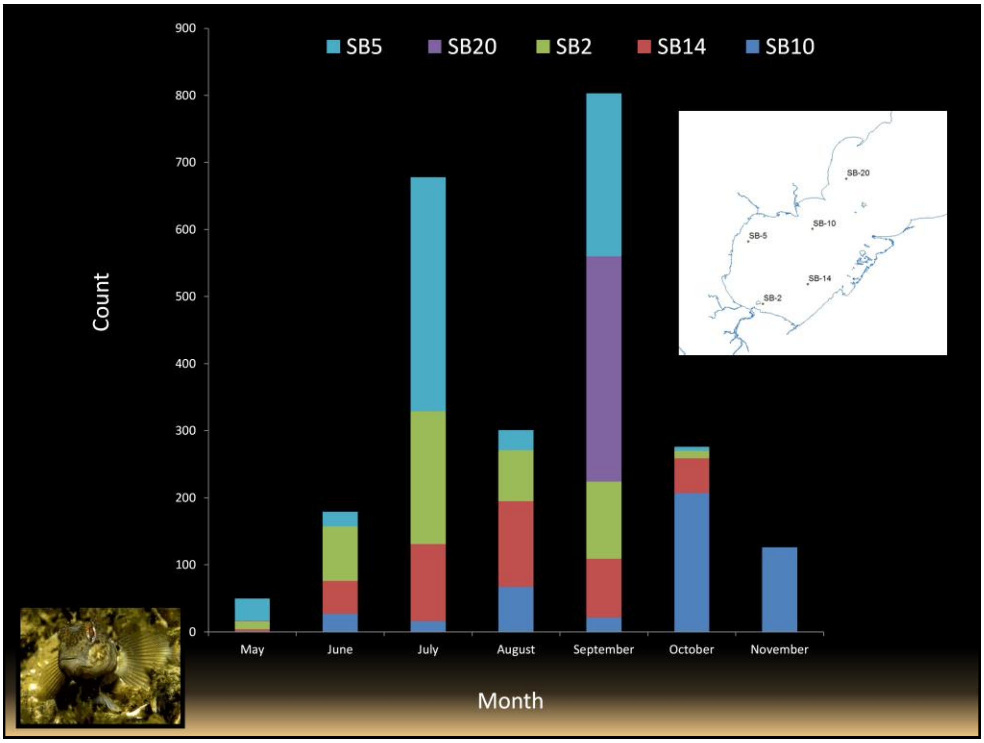
Young lake whitefish feed almost exclusively on cladocerans prior to switching to bethivory in late summer. Notably, few cladocerans are found in the main basin of Lake Huron, which is dominated by calanoid copepods.

Benthivorous Fish

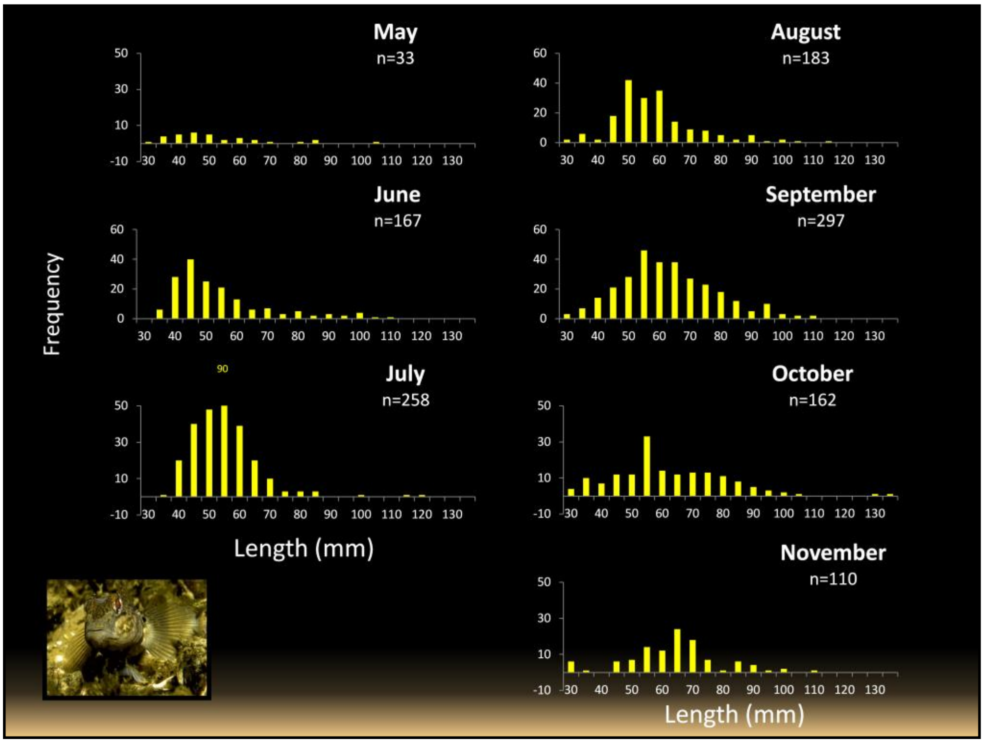
- Round gobies
- Troutperch

- Counts
- Distributions
- Diets

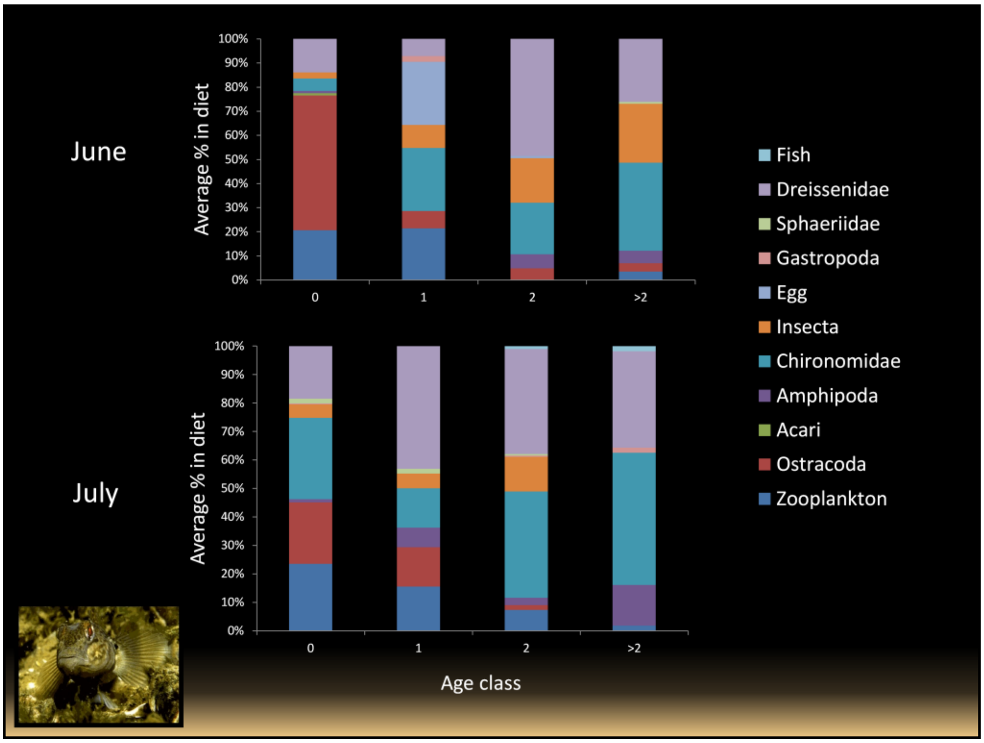
We did similar analyses on some benthivorous fish (looking at overall counts, spatial and temporal distributions and gut contents).



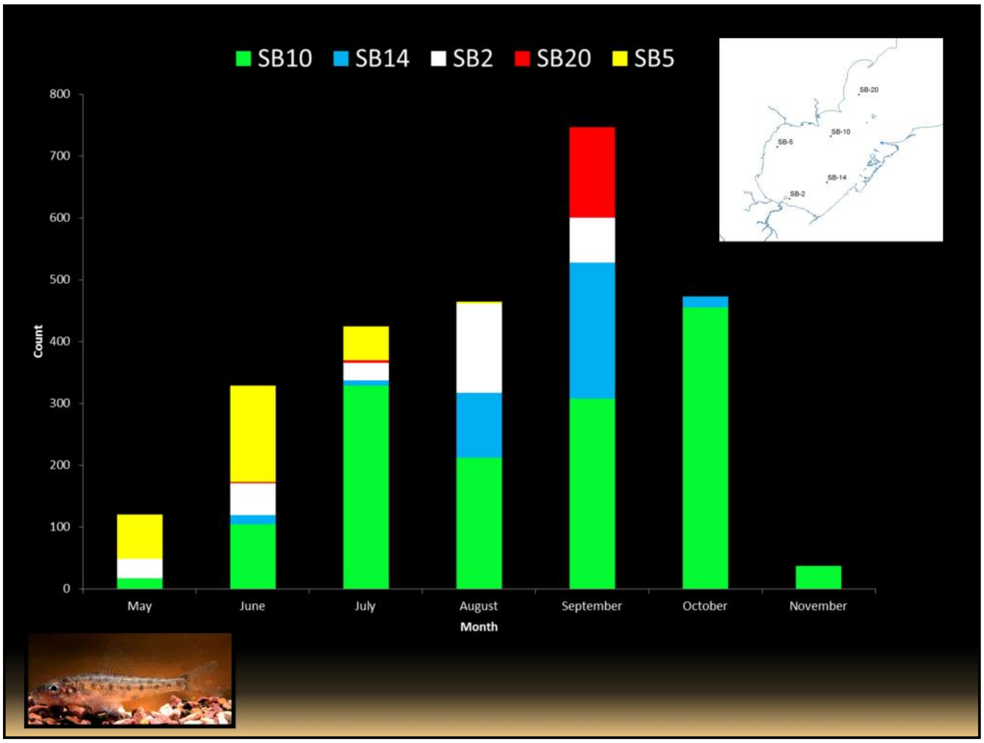
This is for round gobies (the picture is meant to help). Round goby catches in trawls increase over the year, peaking in September. September is also the only month that gobies were caught at the outer bay site. They may be moving around the bay a bit. Some of these distributions will be affected by our sampling, e.g. we didn't sample all sites in November.



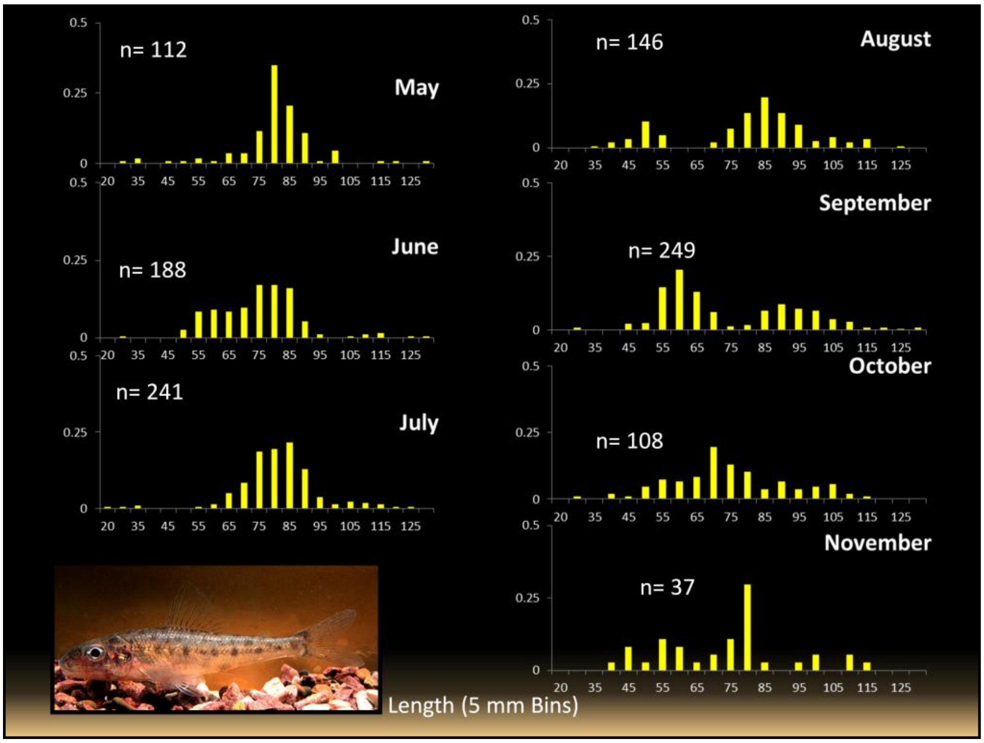
Again for round goby, this time length frequency distributions through the year over the whole bay. The y-axis are actual counts rather than percentages. Literature values place age-0 < 56 mm, 57 mm < age-1 < 63 mm, 65 mm < age-2 < 76 mm. We see no clear cohorts.



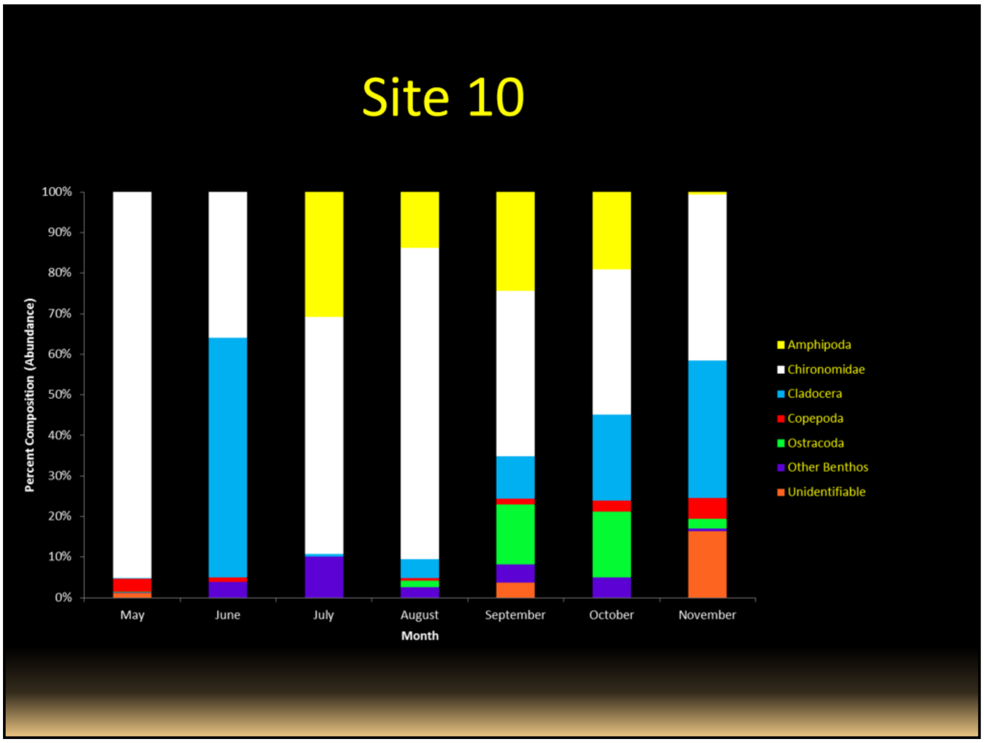
Limited round goby gut content analysis. Age classes are based on the literature values (I did not age my fish). There seems to be a switch from zooplankton/ostracods to larger items as fish get bigger, but some of the smallest fish still have dreissenids in them. Gut contents do seem to depend on site where the fish were collected, and I hope to look at this in greater detail.



Counts of troutperch collected in trawls in 2009. These again increase over the year with a peak in September, though troutperch really seem to like SB10 versus other sites.



Troutperch – always catch a range, no clear cohorts

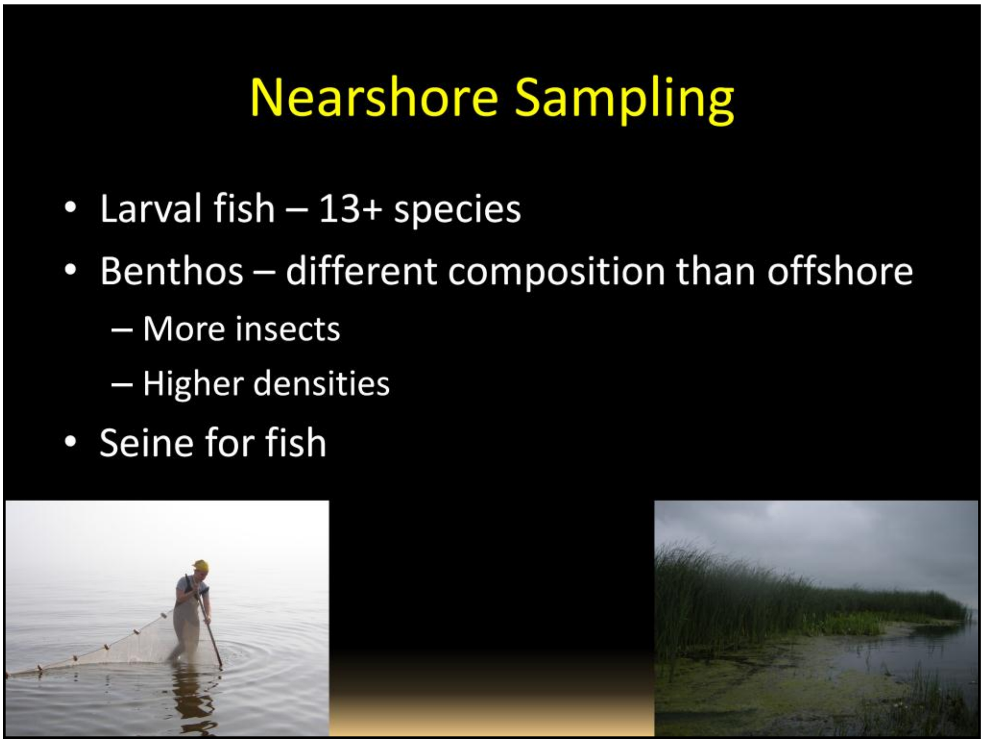


Troutperch gut contents in terms of counts (not biomass) for all months at one site only (SB10, where we caught most of them). There were few dreissenids at this site so it makes sense that they do not show up in gut contents; so far, no dreissenids were found in any troutperch guts from any site.

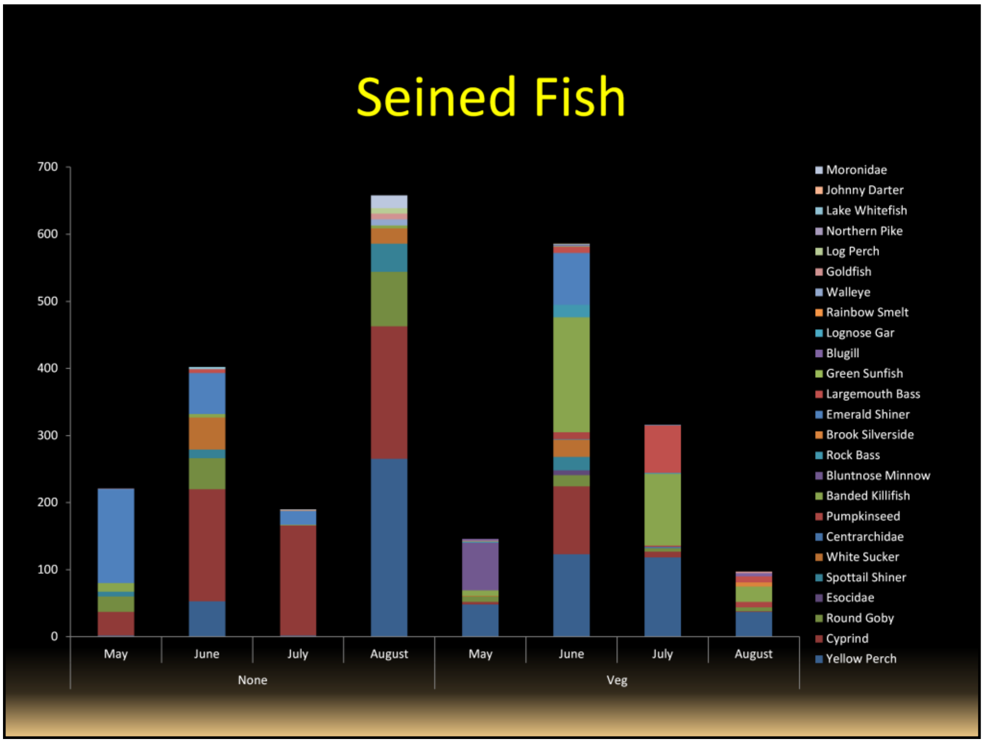
Additional work

- White perch, white bass, shiners, smelt, gizzard shad, (diets done for 2009); suckers (diets mostly done for 2009); freshwater drum
- Energy density
- Sampling in Spring 2011 to get overwinter

Additional work not mentioned in this presentation includes similar analyses (growth, diets) for white perch and white bass (mostly juveniles), shiners, smelt, gizzard shad, suckers (adults), and drum (adults). For many species we will be measuring energy densities. We will also be sampling this spring to evaluate overwinter survival of 2010 cohorts of yellow perch and walleye.



This slide gives a brief overview of the preliminary nearshore sampling results. Much of this data has not been analyzed yet. So far, 13 species have been found in nearshore larval fish samples (there are many more samples left to be sorted). This includes newly-hatched larval walleye found in the channelized portion of the Au Gres River. The benthos in nearshore areas contained more insects, and higher total organism densities than at the offshore sites. We also used a beach seine at 2 vegetated and 2 non-vegetated sites, approximately twice per month, to collect juvenile and adult fish.



Many of the seine samples have not been counted yet, but this graph shows preliminary data for 2009, grouped by vegetation and month. The fish communities in nearshore habitats were highly variable, both spatially and temporally. The most common taxa included yellow perch, banded killifish, round gobies, and cyprinids (mostly sand, emerald, and spot tail shiner). However, many other species were also caught, and many fish species collected with the seine were not caught in the trawls offshore (centrarchids, killifish, young pike). The warm conditions in 2010 should again provide a nice contrast with these data.